THE UNIVERSITY OF ALBERTA

LOCATING WAREHOUSE FACILITIES FOR SASKATCHEWAN BEER DISTRIBUTION

by

© CARL BAILLIE MARX

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF BUSINESS ADMINISTRATION

FACULTY OF BUSINESS ADMINISTRATION AND COMMERCE

EDMONTON, ALBERTA

SPRING, 1970

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Locating Warehouse Facilities For Saskatchewan Beer Distribution", submitted by Carl Baillie Marx in partial fulfilment of the requirements for the degree of Master of Business Administration.

ABSTRACT

The problem of determining the optimum number, size and location of distribution warehouse facilities encountered in physical distribution systems is common to many firms.

In Western Canada, with the population even more sparse and scattered than in many areas in North America, distribution is of particular importance. Since the time and expense to distribute goods is considerable, achieving the proper balance between adequate levels of customer service and minimizing costs of distribution from centralized plants to retail outlets is of considerable economic consequence.

The problem encountered in the distribution of beer in Saskatchewan can be generalized to many distribution systems where there are many retail outlets scattered over a wide area with several sources of supply and a limited number of distribution warehouses or potential locations for such facilities.

This study serves well to illustrate the types of problems encountered in studying real distribution systems. Problems occur in data collection, problem definition and the construction of mathematical models. Difficulties are encountered when consideration must be given to the indivisibility of shipping units, bulk freight movement and the way in which the order frequency of retail outlets and distribution warehouses affects the transportation cost through minimum weight specifications of transportation rate structures.

When the distribution system activities like inventory stocking and reordering are not defined explicitly some of the operational

ABSTRACT

The problem of determining the optimum number, size and location of distribution warehouse facilities encountered in physical distribution systems is common to many firms.

In Western Canada, with the population over vast spaces and scattered thin in many areas in large centres, distribution is of particular importance. Since the time and resources to distribute goods is considerable, achieving the proper balance between adequate levels of customer service and minimizing the cost of distribution from centralized plants to retail outlets is of considerable economic consequence.

The problem encountered in the distribution of beer in Saskatchewan can be generalized to many distribution systems where there are many retail outlets scattered over a wide area with several sources of supply and a limited number of distribution warehouses or potential locations for such facilities.

This study serves well to illustrate the types of problems encountered in studying such distribution systems. Problems arose in data collection, problem definition and the construction of mathematical models. Difficulties are encountered when consideration must be given to the indivisibility of shipping units, bulk freight movement and the way in which the order frequency of retail outlets and distribution warehouses affects the transportation cost through minimum weight specifications of transportation rate structures.

When the distribution system operations were thoroughly examined and researching was defined underlying part of the operations.

aspects of a distribution system lack standardization, conforming to the personal preferences of individuals controlling the situation at different points in the system. Thus, a problem occurs in defining the operating characteristics of a distribution system.

The analysis of the Saskatchewan beer distribution system assumes the present sources of supply are given and projects the sales to retail outlets for different years according to geographic area and order size. The transportation network and modes of transportation are given and operational aspects such as inventory stocking and reordering are assumed to continue according to the current operating practise.

The eight warehouse facilities currently in use are considered as potential locations for distribution warehouses. The purpose of the analysis is to discover whether any of the facilities can be discontinued and consequently which facilities should be reconstructed since many are in a poor state of repair.

The conclusion is that in the long run all eight distribution warehouse facilities will be required. Although some savings would result from the discontinued use of some facilities in the short run, the costs incurred in closing and later reopening these facilities will offset any potential short run savings.

The study of the system for distributing beer in Saskatchewan also places distribution system activities in perspective relative to the cost of operating the system and the level of customer service provided. Thus other areas for potential cost savings through continued analysis are revealed.

ACKNOWLEDGEMENTS

This study was made possible with the cooperation and assistance of the Saskatchewan Brewers Association Limited. I am particularly indebted to Mr. R. Hallamore of Molson's Western Breweries Limited for his assistance with both information and funds as well as the other member breweries of the Saskatchewan Brewers Association Limited for their cooperation. Mr. R. McMartin and Mr. N. Wilken of the Saskatchewan Brewers Association Limited were extremely helpful in the collection of data and discussion of the problem.

Professor D. H. Bent made several suggestions and discussed a number of methods useful in the determination of the location of fixed facilities.

The University of Alberta Computing Center deserves special mention since their facilities provided the vehicle for performing most of the analysis. In addition, Digital Analysis & Technical Assistance Ltd., were generous in preparing much of the data and programs for computer processing.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

The study of distribution systems and the application of operations research techniques to distribution problems is certainly not new. The analysis, review and planning of distribution systems is as common in business firms operating in Western Canada as it is elsewhere. However, the application of operations research techniques and the use of digital computers to analyze and devise solutions to distribution problems is not as common.

In part this study serves to demonstrate the application of operations research and the use of a digital computer to analyze and devise solutions for a distribution problem. The problem, the location of distribution warehouse facilities, is a typical problem faced by many Western Canadian firms. Although specific aspects of the distribution of beer in the Province of Saskatchewan differ from the problem encountered by other firms, the procedure used can be generalized to other cases.

Distribution systems exist to move goods from points of supply to points of demand. It is the distribution system that adds time and place utility to goods by making them available as required for consumption. Since the cost of providing time and place utility increases as the distance between supply and demand points increases, the physical distribution of products in the Canadian setting is one of the major economic undertakings. In Western Canada, with the population even more sparse and scattered than in Eastern Canada,

distribution is of particular importance. With greater time and expense to distribute goods, achieving the proper balance between adequate levels of customer service and minimizing costs of distribution from centralized plants to retail outlets, is of considerable economic consequence.

The problems of achieving adequate levels of customer service and minimizing distribution costs are important in an economic sense and also because they are frequently the problems for which management has the fewest answers. Questions of the "What if...?" variety, directed at a distribution system can not be answered nor can plans be formulated to correct inefficiencies until the range of behavior of the system is brought to light.

The influence of environmental and technological changes that affect distribution systems results in a continuing need for their evaluation. The trend toward higher warehousing costs, decreased shipping lead times, population growth, increasing urbanization, and changes in marketing methods alters the balance between cost and service. In order to maintain a proper balance the system must be evaluated and adapted to changing conditions. Distribution systems must be planned and evaluated in a dynamic setting that precludes the establishment of specific optimum solutions for all time.

Logistics problems have received more attention from operations research people since 1950 than any other class of business problem. Unlike many business problems solved by operations research which are directed toward finding least-cost solutions, logistics problems are composed of conflicting objectives which must be balanced to achieve a solution. Logistics problems are encountered in organizing

and managing the flow of materials from suppliers through to customers. McElhiney and others define business logistics as:

> ...that phase of economic activity which concerns itself with assessing the need of goods and services for time utility and place utility and providing them with these utilities.[1]

Physical distribution is concerned with providing goods with time and place utility. Our principal interest is in physical distribution as distinguished from the logistics problems encountered in marketing functions such as promotion, pricing and so on.

A physical distribution system is defined in terms of the transportation network and system of warehousing that links supply points with demand points. The problems that arise generally involve the balancing of customer service requirements with the cost of providing various levels of service.

General techniques (with the exception of simulation models of specific systems) have not been developed to optimize or near optimize distribution systems in total but have tended to optimize separate components. C. W. Churchman and others state:

> ...although simultaneous optimization of all phases of a system is desirable, practical restrictions usually require sequential optimization of parts of the system accompanied by adjustments of the "phase-optima" to approach an over-all optimum.[2]

Considerable research has been directed at solving distribution problems for existing distribution systems. The study of inventory

---

[1] Paul T. McElhinery, Charles L. Hilton, Introduction to Logistics and Traffic Management, Wm. C. Brown Company, Publishers, Dubuque Iowa, 1968, p. 1.

[2] C. West Churchman, Russell L. Ackoff, E. Leonard Arnoff, Introduction to Operations Research, New York, 1957, John Wiley & Sons, Inc.

stocking and ordering policy has received a considerable amount of attention since the turn of the century. More recently with development of linear and dynamic programming, solutions for the allocation of supply to demand points and distribution facilities have been forthcoming.[3]

In many of these problem formulations optimum solutions have been derived. We would be naive to think that these optimum solutions result in an optimum system, however. Since many of the factors are interrelated and the solutions overlap, consideration must be given to the entire system and its sensitivity to the various solutions to these sub-problems.

A warehousing system becomes necessary when the time or the cost required to fill customer orders direct from supply points exceeds the allowable limit established by competition, company policy, the public interest or other factors relating to the ability to develop or maintain sales in a particular geographic area. The economic development of Canada clearly requires that goods be readily available in even some of the most remote areas in order to ensure their continued growth.

Canadian companies are often faced with the problem of balancing the size, number and location of manufacturing plants and the design of the distribution system that will be required to cover a sufficient market area to justify the plant capacities. More frequently however, the logistics system components cannot be designed concurrently because of previous commitments to serve certain geographic areas and sunk

---

[3] Ibid., p. 195-197.

costs in existing facilities. Furthermore, the fact that the production facilities, retail outlets and the connecting distribution system are usually owned by separate firms requires coordinated planning to achieve total systems efficiency. This is usually difficult to accomplish, particularly if the distribution system handles many different products for a number of plants not owned by one firm and must make deliveries to a variety of different types of retail outlets typically owned by many firms.

Since economies of scale dictate to a large extent that manufacturing and process facilities be of a size considerably greater than the immediately surrounding market area will support in Canada, the development of extensive distribution systems with their associated facilities is essential.

For these reasons the most fruitful approach is often to consider production facilities and retail outlets of a distribution network fixed. For obvious reasons of size, investment, useful economic life and inability to convert to another use, production facilities are fixed except in the long-run. Retail outlets on the other hand, unless they are specialized for some particular usage, can usually be closed or opened readily as market conditions change or shift from one geographic area to another. For this reason studies of distribution systems frequently employ a market grid concept, dividing the area under consideration into many smaller areas. Each area then is assigned a particular number of potential outlets of the various types on the basis of demand projections and past data that indicates the number of retail outlets required to serve the demand.

The study of distribution systems when all facilities are not

considered fixed has not met with the same degree of success as the case of fixed facilities. This has been due in part to the non-linearity of the cost functions involved and the multitude of factors that must be considered, many of which cannot be readily reduced to quantifiable terms.

Equally difficult has been the task of reducing the sheer size of the problem down to a size that permits solution.

The fixed facility location problem is formulated by Leon Cooper in general terms as:

Given:

(1) The location of each destination.

(2) The requirments at each destination.

(3) A set of shipping costs for the region of interest.

To determine:

(1) The number of sources.

(2) The location of each source.

(3) The capacity of each source.[4]

The number of possible configurations becomes enormous as the number of potential locations grow. For m potential locations there are $2^m - 1$ configurations to consider if at least one location must be established. Thus if there are eight potential locations there are 255 possible configurations; if there are sixteen potential locations there are 65,535 possible configurations. Leon Cooper points out this

[4] Leon Cooper, Location-Allocation Problems, Operations Research, Volume II, Number 3, (May - June 1963), pp. 331-43.

difficulty when he states that: "The existence and use of digital computers barely makes a dent into some of the combinatorial problems arising when computation is undertaken."[5]

This study is focused on the location of facilities problem and seeks a solution in terms of the number, size and location of facilities. Manufacturing or plant facilities are considered to be fixed and as well the retail outlets are considered fixed in terms of the number required to meet the demands in each geographic area. Thus the size, number and location of warehouse facilities must be determined within the constraints of the transporation network, prior committments and established supply and demand points.

Since techniques devised to date have been largely directed at solving for the allocation of demand and supply and analyzing a particular warehousing configuration, the task of determining those configurations that merit consideration is of first importance.

The study of the location of distribution facilities was undertaken on behalf of the Saskatchewan Brewers' Association Limited. Although this organization is the distributing agent for the Saskatchewan breweries and maintains warehouse facilities for this purpose, they do not incur all the costs in distributing brewery products from the breweries to the retail outlets. The Saskatchewan Liquor Control Board pays for transportation of the brewery products from the warehouse facilities to the retail outlets.

---

[5] Ibid.

If this cost sharing arrangement could be assumed to remain unchanged, even if the number, size or location of warehouse facilities were changed then clearly the Saskatchewan Brewers' Association Limited would minimize their portion of the distribution expense by warehousing at the brewery sites. However, it is recognized that changes in the sharing of distribution costs would be necessary to provide an equitable situation for both parties if changes are made in the number, size or location of warehouse facilities.

Since the sharing of distribution costs is a problem to be solved by the organizations involved in the distribution of brewery products this study does not attempt to present methods of sharing distribution costs or discuss the merits of the present arrangement. The important aspect of distribution for all organizations involved is the total cost of operating the distribution system for the movement of brewery products from the breweries to the retail outlets.

The minimization of total physical distribution costs is an objective of importance to all organizations sharing in these costs. Therefore the problem of determining the number, size and location of warehouse facilities is examined in the context of the total physical distribution system.

In order to reduce the scope of this study to the limitations of time and finances available many of the component problems are left unsolved. These include the optimum inventory policy that accounts for customer service, warehouse space, railway car loading and so on, the number of loading docks and their location, manpower deployment and other areas.

The possible political considerations are not discussed although

they could outweigh some of the cost factors. No attempt is made to define constraints of this nature or speculate on their repercussions. Some of the assumptions which specify that present methods will continue to be used may very well invoke the comment "This may be true, but what if we changed ...?". Assumptions are made to define the problem and impose sufficient limitation to permit solution within the constraints of time and expense. As a result of this study changes to the distribution system and alteration of the assumptions made can be suggested with a better understanding than was previously possible.

Chapter II discusses the brewing industry, products, and regulations. It provides background information on the Saskatchewan beer distribution system and developments leading up to the location of warehouse facilities problem.

The starting point for the analysis of a distribution system is to isolate the areas of expense and examine those activities which account for the major portion of the total operating cost affected by the number, size and location of distribution warehouse facilities. For the Saskatchewan beer distribution system the greatest expense is incurred in transportation (Brewery to warehouse and warehouse to retail outlet) and in the operation of warehouse facilities.

The underlying factor determining the magnitude of these costs to a large extent of course is the volume demanded by the ultimate consumer purchasing these products from the retail outlets.

Chapter III examines each area of distribution cost and develops a methodology for projecting demand and estimating the costs of transportation and warehouse operation.

Using the methodology developed in Chapter III a distribution

system model is developed and presented in Chapter IV. The model develops cost projections for each of the possible warehouse configurations assuming different years and various warehouse construction cost factors.

The results of the distribution system model are then analyzed to isolate the configurations of warehouse location, number and size that merit consideration as best solutions. In addition, the degree of sensitivity of the cost of various warehouse configurations is determined.

The results provide conclusive evidence of the direction in which the optimum solution lies. Seven configurations of warehouse location, number and size are isolated as the best or next best alternatives irrespective of the year or building construction cost within the selected range.

The solutions for less than eight warehouse facilities become less and less attractive in successive years. The result is that by 1982 all solutions for fewer than eight distribution warehouse facilities will incur a greater expenditure than the solution of establishing all eight facilities.

The question of whether there should be more than eight facilities is not answered by the analysis. However, the selected potential locations for warehouse facilities are in the largest population centers in each area and only a very few centers would be feasible in Saskatchewan where the population is predominately rural. Therefore extension of this analysis to include other potential locations is of limited value.

This study provides a definite indication of the approach that should be taken to improve the distribution system and other areas

that could be examined for improvements. The region in which the optimal solution lies for the number, size and location of distribution warehouse facilities for Saskatchewan beer distribution is set out and the plan for reconstructing warehouse facilities is discussed.

CHAPTER II

THE DISTRIBUTION OF BREWERY PRODUCTS IN SASKATCHEWAN

In order to adequately describe the system for distributing brewery products in Saskatchewan it is necessary to provide a brief outline of the organizations involved, the nature of the products and their manufacture as well as the regulations affecting beer distribution. In addition, the demand for beer products served by retail outlets, the system of warehousing presently employed and the transportation network are discussed at some length.

Organizations

The brewing industry in Canada at one time was characterized by many smaller breweries dispersed across the country roughly in proportion to the population. They were typically family enterprises and enjoyed an expanding market. This situation has changed considerably today. In every region there is an oligopolistic situation where large breweries of comparable (but not necessarily equal) size compete. After the first world war a movement towards consolidation gained momentum. This is shown by the fact that at the close of World War II there were thirty independent companies operating sixty-one breweries. By 1965 there were only ten companies operating fifty-two breweries. In 1966 Molson Breweries Limited operated nine breweries, John Labatt's Limited operated eleven breweries and Canadian Breweries Limited operated nineteen. Thus of the fifty-one breweries operating in 1966, only nineteen were operated by the seven smaller firms.[1]

---

[1] Brewers' Association of Canada, Brewing in Canada, Ronalds-Federated Montreal, 1965.

Brewery consolidation has not meant just consolidation of ownership. It has also meant a reduction in the total number of breweries. Largely as a result of prohibition laws, the number of breweries in Canada decreased by forty-two per cent from 1915 to 1920.[2] This trend was also general throughout the world brewing industry. Between 1870 and 1962 the number of breweries in the United Kingdom dropped from an estimated 32,682 to 317.[3]

The number of breweries is a balance between achieving economies of scale through centralized production facilities and the cost of transportation to retail outlets. In Canada, where the population is widely dispersed it has been necessary to sacrifice some of the economies of scale in return for reduced transportation costs. Thus it is not unexpected that the average production per brewing plant was 4.87 million gallons in Canada in 1962, while the United States average was 11.30 million for the same period.[4] In the province of Saskatchewan during 1962 the average production per brewing plant was 2.11 gallons,[5] further illustrating the regional nature of the brewing industry and its location close to the markets it serves.

Since beer is heavy, far from durable and the raw materials are light and fairly ubiquitous (i.e. water) the breweries are located near consumers rather than sources of material. However, developments in transportation technology have made it more economical to ship beer and

---

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Calculated from data contained in Brewers' Association of Canada Sales Bulletin, May 17, 1968.

production technology has made it possible to develop products which are more durable. Thus the forces working toward industry consolidation are also favored by advances in technology. Another force which encouraged consolidation was market growth. The market had only been expanding at about the same rate as the growth in population and until recently, disposable income. Thus the only route to follow for firms to expand more rapidly was through merger and acquisition.

The Canadian brewing industry has not become integrated either vertically or horizontally to any significant extent. Some like Molson Breweries Limited with a hops farm in British Columbia have become vertically integrated while many, regulations permitting, have opened retail beer stores. Forward integration like the ownership of retail outlets has usually been discouraged by the provincial governments, particularly in Western Canada, while backward integration like that undertaken by Molson Breweries Limited has been quite limited.

It is interesting to note in the last few years those brewing companies which have been the most successful in gaining an increasing share of the market and showing favorable profits are those pursuing diversification aggressively. A newspaper article carried the following item:

> John Labatt Ltd. have announced the opening of a new $650,000 centre for scientific research. The company said research in the centre will be aimed at "strengthening Labatt's facilities for diversification into fields other than brewing". The Labatt research program was launched in 1952 in a 300 square foot pilot brewing plant.[6]

---

[6] Southern News Service Ltd., The Edmonton Journal, Edmonton, Alberta, February 7, 1969.

Pitfield, MacKay, Ross and Company in their annual review of Molson Industries describe the company as a "fast growing conglomerate active in Canada, the U.S.A. and Europe," formed by the association of Molson Breweries Limited and Anthes Imperial Ltd.[7] A further statement about the Company seems typical of this new outlook in some of the brewing companies.

> Molson's new president, Mr. Donald S. Wellmot, who directed Anthes Imperial in a diversification program which increased Anthes' sales at a 25% per year rate from $14 million in 1958 to $97.2 million in 1967, is expected to add impetus to the diversification of the Company. Particular interest is being centered on diversification abroad (where Molson Industries presently obtain about 13.0% of its gross sales) with an emphasis on growth in the U.S.A. Sound financial backing for diversification is available through the cash throw-off from Molson's brewing operation.[8]

Canadian Breweries Limited represents a consolidation of ownership of a number of Canadian breweries. They have not diversified significantly from the brewing industry. In addition to their Canadian brewing interests they also have interests in brewing in Ireland and the United States. Although Canadian Breweries Limited operate the greatest number of plants in Canada, in recent years they have experienced a sales volume increase below the industry average, in some years only managing to hold their own.

Brewery sales by Molson Breweries Limited are second in Canada to Canadian Breweries Limited. They have approximately thirty per cent of the market sales and account for seventy per cent of their sales in Western Canada. Beer sales represent about sixty per cent of their total sales dollar and is largest in terms of capital

---

[7] Pitfield, MacKay Ross & Company, Annual Review of Molson Industries, n.p., January 1969, p. 4.

[8] Ibid.

employed.[9]

John Labatt's Limited accounted for about twenty-seven per cent of the brewery sales in 1968 and their sales continue to increase more rapidly than the industry average. In 1968 beer sales still accounted for about eighty-four per cent of their total sales although they are continuing to diversify.

Retailed information on the variation of costs between breweries of different sizes in different locations is very limited, therefore indications of the overall cost only can be given. During 1968 the following costs were experienced by Molson Breweries Limited, expressed in percentages:

Operating Costs:	
Labour	34.7
Malt barley and other materials	14.5
Packaging materials	11.3
Advertising, freight, etc.	14.5
Total Operating Costs	75.0
Operating Profit	25.0
Net Sales	100.0

Depreciation during the last five years has been between 4.68 per cent in 1964 and 3.38 per cent in 1967 of average gross fixed assets.[10]

The brewery industry in Canada was one of the first industries to be unionized early in this century. Today Canadian breweries are more highly unionized than in the United States. Although labour relations have generally been good with brewery workers traditionally receiving higher wages than industry in general, there are occasional

---

9 Ibid.

10 Ibid.

labour disputes which seriously affect the industry. In 1968 a strike occurred in Ontario from June 21 to July 17, the peak sales period, and sales were markedly affected.

The various breweries in the industry have formed associations both provincially and nationally. The national association is the Brewers' Association of Canada located in Ottawa.

In most cases the provincial associations serve as distributing agents for the member breweries as well as serving in a public relations capacity for the industry, particularly with respect to negotiations with government authorities and associations formed by retail outlets. In Saskatchewan the Saskatchewan Brewers' Association Limited is the distributing agent for the five provincial brewery members.

The breweries operating in Saskatchewan are as follows:[11]

1. The Carling Breweries (Saskatchewan) Limited,
   921 Albert Street, Regina
2. O'Keefe Old Vienna Brewing Company (Saskatchewan) Limited,
   519 Second Avenue, Saskatoon
3. Sicks' Bohemian Brewery Ltd.,
   554 - 17 Street West, Prince Albert
4. Molson's Regina Brewery Ltd.,
   Dewdney and Toronto Street, Regina
5. Labatts' Saskatchewan Brewery Limited,
   Saskatchewan Crescent and 8 Street, Saskatoon

Canadian Breweries Limited own Carling Breweries (Saskatchewan) Limited and O'Keefe Old Vienna Brewing Company (Saskatchewan) Limited in Regina and Saskatoon respectively. Molson Breweries Limited own Molson's Regina Brewery Ltd. in Regina and also Sicks' Bohemian Brewery

---

[11] Throughout this paper the Saskatchewan breweries will be referred to as Carling's, O'Keefe's, Sicks', Molson's, and Labatt's respectively.

Ltd. in Prince Albert. John Labatt Limited only owns one Saskatchewan Brewery, Labatts' Saskatchewan Brewery Limited in Saskatoon.

The Saskatchewan Brewers' Association Limited (SBA) was established by the Saskatchewan breweries. The SBA is owned by these breweries and receives its direction from a board consisting of five members, one from each brewery. The function of the SBA is primarily to act as the exclusive distributing agent for the member breweries. In addition, it serves the breweries in a public relations capacity. The SBA is responsible for relationships with the Provincial Liquor Control Board (LCB), the Hotel Association of Saskatchewan, and the general public.

As the distributing agency the SBA is responsible for the transportation and intermediate storage of brewery products between the breweries and the various retail outlets. As well they handle the collection, storage and shipment of empty containers back to the breweries.

Eight warehouses are currently operated by the SBA for intermediate storage of beer between the breweries and retail outlets. These are located in the following Saskatchewan cities: Moose Jaw, Swift Current, Weyburn, Yorkton, Regina, Saskatoon, Prince Albert, and North Battleford.

Ordering from the breweries, storing and warehouse handling is carried out by the SBA. However, orders filled from the warehouse for delivery to retail outlets are placed by the outlets with the Provincial Liquor Control Board (LCB) who maintain personnel for this purpose at each warehouse. These orders are processed by the LCB who also collect payment from the retail outlets. The order make-up and handling is carried out by the SBA at the warehouse under the supervision and direction of the LCB. In effect the products are sold to the LCB

who take delivery at the warehouse as required to fill orders placed by the retail outlets. All beer must be sold through the LCB in Saskatchewan.

The Provincial Liquor Control Board is an organization established by the Government of the Province of Saskatchewan to control the sale and distribution of alcoholic beverages. In addition to acting as an intermediary between the SBA and the retail outlets, the LCB operate retail stores which sell alcoholic beverages, including beer, to the public for off-premises consumption. They are also the licensing body for breweries and retail outlets.

The retail outlets consist of beer parlors, beverage rooms, dining rooms, cocktail rooms, restaurants, clubs and canteens. As well, in isolated areas and summer resorts, special vendors are licensed (usually drug stores) for the off-premise sale of alcoholic beverages.

Beer parlors and beverage rooms are located in hotels, the distinction between them being that men only are allowed in beer parlors while both men and women are permitted in beverage rooms. Beer parlors and beverage rooms do not sell alcoholic beverages other than beer. Both draught beer and bottled beer is offered for sale and consumption on the premises. Bottled beer (packaged beer) is also available for off-premise consumption.

Dining rooms, cocktail rooms and restaurants serve a variety of alcoholic beverages in addition to beer for on-premise consumption. Generally a meal must be served to the patrons of dining rooms and restaurants in order to serve them an alcoholic beverage.

In addition to these outlets, clubs are often licensed to sell

alcoholic beverages to their members and guests for on-premise consumption. Some clubs and canteens serve only beer, and some serve alcoholic beverages only occasionally, obtaining a special permit each time. In 1967 the Saskatchewan Liquor Licensing Commission and Liquor Board reported licenses issued for twenty beer parlors, four hundred eighty-six beverage rooms, eighty dining rooms and restaurants, fifty-one cocktail rooms, and one hundred three clubs and canteens in the province of Saskatchewan. In addition there were about ninety liquor vendors.

Brewery Products

The name beer is generally applied to the products produced through fermentation of malt and hops. Webster's dictionary defines beer as "a malted and hopped somewhat bitter alcoholic beverage"[12]; thus beer refers to the specific products called ale, lager, porter, stout, and so on. Occasionally, however, beer is used as a synonym for lager.

Beer is a very ancient beverage and according to archaelogists was first produced at about the same time as bread. The popularity of beer continued from earliest times into the ancient Greek and Roman cultures. Consumed primarily as a staple food, rich in nutrients, beer became even more common during the Christian age. Christian monasteries brewed and improved the quality of beer.

---

[12] Webster's Seventh New Collegiate Dictionary, based on Webster's Third New International Dictionary, Thomas Allen & Son Limited, Toronto, Ontario, 1967.

Beer accompanied world explorers and was first introduced to Canada by the French. The French intendant, Jean Talon, established the first Canadian commercial brewery. The industry as we know it today, however, is usually considered to have its beginnings with the establishment of a brewery on the banks of the St. Laurence by John Molson in 1786. Today Molson Breweries Limited operate the largest brewery in Canada at the same Montreal location. To appreciate the age of the brewing industry in Canada, the companies and year of founding of some of the prominent names in brewing are: Molsons 1786, Dow 1790, John Labatt 1828, Carlings 1840, O'Keefe 1846, Lucky Lager 1858.

The later centuries of the brewing industry were accompanied by improvements in the quality and distribution of beer. However, the basic production technique, natural fermentation, continues in the early traditional manner. This does not mean that the production techniques are unique. "There are as many differences in technique as there are breweries, and no one beer is quite the same as any other."[13]

Barley malt is the basic ingredient in beer. Barley malt is barley which having been allowed to grow to a limited extent is kiln dried. In Canada barley malting plants are located at Calgary, Winnipeg, Fort William, Toronto and Montreal. Malt is shipped from these plants to the Saskatchewan breweries.

Bottled beer is becoming increasingly popular. It is pasteurized after bottling by heating the bottle and contents to about one hundred

---

[13] John Vaizey, The Brewing Industry 1886-1951, An Economic Study, Sir Isaac Pitman & Sons Ltd., London, 1960, p. 78.

and forty degrees fahrenheit for ten minutes and then quickly cooling again. In this way, and with the addition of other ingredients in some instances, bottled beer is much more durable. The breweries however, still feel that bottled beer should be consumed within three months. Kegs, or draught beer is not pasteurized since it is intended for immediate consumption. It is not recommended to store draught beer for more than three weeks. The carton sizes for compact twelve ounce bottled beer are six, twelve and twenty-four bottles containing 0.45, 0.9, and 1.8 gallons respectively. Draught beer is stored in aluminum kegs called half kegs and quarter kegs containing 12.5 and 6.25 gallons respectively.

Regulation of Beer Distribution

The legislative control of beer consumption has a history almost as old as the industry. By the thirteenth century in England, price regulations were in effect in addition to the medieval laws governing quality and quantity.

Legislative control has thus been one of the major determinants in the development of the industry. Indeed John Vaizey writes of the situation in the United Kingdom "...the State's imposition of licensing and duty has determined the broad structure of the market, affecting, in particular, the general level of prices and the number and location of retailers."[14] His remarks are as applicable to the Canadian industry as they are in the United Kingdom.

---

[14] Ibid.

The Federal Government in Canada imposes an excise duty on beer of forty-two cents per imperial gallon. This is of special significance since the beer is measured and taxed at the fermentation stage of the production process. The tax is payable immediately although it can be several months before the beer is actually sold. The Brewers' Association of Canada estimated that the carrying charges for inventory held by Canadian breweries was therefore $600,000 higher in 1965 because of the tax.[15] The tax also has the effect of introducing some artificial problems of production because extra precaution must be taken to avoid wastage once tax has been paid on the beer. In addition to the excise duty, brewers must also contend with the twelve per cent federal sales tax on manufactured goods. This brought the 1968 taxation to about $8.69 per 12.5 gallon keg. The breweries receive approximately $23.12 per keg in Canada, thus netting about $14.43 after the excise and sales taxes.[16]

The provincial governments have authority over sales and distribution in their respective provinces. Through liquor control boards the number and location of retail outlets is controlled as well as breweries. They are actively engaged in distribution through government owned retail outlets for off-premise consumption and in some provinces, particularly Saskatchewan, a considerable degree of control is exercised over the distribution to all outlets regardless of whether the government owns the distribution facilities or not.

---

[15] Op. cit., Brewers' Association of Canada

[16] Ibid.

The retail outlets are divided into several categories by the licensing law. These are highly regulated as well with seating capacity, decor, entertainment and so on, falling within the administrative powers of the provincial liquor control boards. In Saskatchewan beer for home (off-premise) consumption is available through government operated liquor stores, specially licensed vendors, beer parlors, beverage rooms and in the larger centers by home delivery service. On premise consumption is offered in beer parlors, beverage rooms, restaurants, dining rooms, cocktail lounges, private clubs, military messes, lounges and dining cars on trains and planes. None of the outlets are permitted to serve or sell liquor on Sundays and as well their hours of operation are regulated during the remainder of the week.

The duty, taxes and legislative control reduce the scope for retail competition. The location and operation of retail outlets is closely supervised and regulated thus tending to standardize marketing practises at the retail level. With the government imposed taxes and fixing of its own price mark-up on brewery products between the breweries and the retail outlets the retail price is disproportionately greater than the price paid to the brewer. Thus, even if government price fixing were not in existence the scope for retail price competition is strictly limited.

The quality of beer can be varied by the brewer and since most consumers are not expert judges there exists wide scope for imperfections in the market. Thus the price of beer is not closely tied to production costs. However, it should not be assumed that the more profitable breweries are necessarily producing the lower quality beers. Because of the organization in most breweries, commercial considerations are

often subordinate to technical expertise and they usually brew to a greater precision of quality and taste than the market requires. Perhaps this is also an endeavor to maintain their own high standards of quality and discourage further government regulation.

The Demand for Beer

The market for beer is characteristically stable. Although many factors affect per capita consumption, for the country as a whole, significant changes take place only over long periods of time. The quality, price and ease of purchase are certainly significant. However, disposable income, state of the economy, price of competitive beverages and the weather are the underlying factors affecting per capita consumption. Generally the market expands at about the same rate as the growth in adult population predominately in the twenty to fifty year age group.

Since 1926 the consumption of beer and spirits have followed the disposable income increase very closely until about ten years ago. From this point, income rose much more rapidly than the increase in consumption of either beer, wine, or spirits. However, wine and liquor consumption did move up steadily during this period while beer consumption remained generally at the same level. Since 1949, in Canada, per capita consumption of wine has increased 38.9 per cent, spirits 27.9 per cent, carbonated drinks (estimated) 23.0 per cent and beer 5.3 per cent.[17]

Per capita consumption changes have varied according to geographic region. As well, preferences for different beers is markedly different in various regions.

---

[17] Ibid.

Western Canadians consume lager in preference to ale. West of Ontario the highest ale consumption is in Manitoba -- 4.1 per cent -- while in Quebec ale consumption is 95.5 per cent and in Ontario 64.4 per cent of the total gallons consumed.[18]

In Saskatchewan, wide fluctuations in personal disposable income are experienced with good and bad crop years and the ability of the farmers to market their production. In the period 1949 to 1962 increases have been: spirits 51 per cent, wine 47 per cent and beer 20 per cent.[19]

The trend has been toward packaged or bottled beer, rather than draught beer. This has been attributed largely to the increasing consumption of beer at home rather than at facilities for on-premise consumption of draught beer. At the outbreak of World War II, 45 per cent of the beer sales in Canada was draught beer while today it accounts for only about twenty per cent of the total gallons consumed. This change has not been true in all areas consistently. Changes in the price of draught or bottled beer have occasionally reversed this trend in some provinces for a period of time.

The demand for beer as it relates to the physical distribution of beer must be defined by geographic area in order to relate the movement of goods through the distribution network to their ultimate destinations.

Unfortunately statistics on beer consumption in Canada, like many other product statistics is usually summarized by province. Thus,

---

18 Ibid.

19 Ibid.

less is generally known about the distribution of demand or product preferences within each province. Statistics on consumption that are readily available therefore are often of limited value to the distribution system planner.

The System of Warehousing

The SBA currently operate eight distribution warehouses in Saskatchewan to handle the distribution of full goods from the breweries to the retail outlets and receive empty bottles and kegs for their return to the breweries. According to Heskett and others: "When located between a supply area and a production point or between a production point and a market, a materials handling warehouse serves primarily as a storage-in-transit point."[20] This is very much the function of theSBA warehouses. The main activities at each are receiving full goods and empty containers, holding each in storage, selecting orders of full goods, consolidating empty containers, shipping the full goods to retail outlets and shipping empty containers to the breweries.

The warehouses serve as depots for the return of empty bottles and kegs. Thus the empty container return system shares warehouse facilities and personnel with the system for the distribution of full goods. The warehouse is the only point at which the two systems interact except at the brewery locations. The interaction at the warehouses is not a necessary characteristic of the distribution system and could very well be altered if a study of the system for returning empty

---

20 J. L. Heskett, Robert M. Ivie, Nicholas A. Glaskowsky Jr., Business Logistics, Management of Physical Supply and Distribution, Ronald Press Company, New York, 1964, p. 378.

containers were to advise such a change. Since the shipping rates are not affected by the availability of a return haul and the necessary equipment, personnel and space requirements at each warehouse can be determined separately for the full goods distribution system, this study will not include an analysis of the empty container return system.

It is recognized that there are economies to be gained by using the same warehouses for both full goods and empty container distribution, however the type of storage required for full goods requires security and controlled temperatures that are not required for empty containers. Thus it appears only reasonable that the warehouse space requirement for both systems will not be completely interchangeable. Only about eighteen per cent of the bottles from full good sales are returned and they only incur a freight cost in their return from the warehouse to the brewery. Thus, while the costs are less, the low return ratio indicates a need for investigation and perhaps changes to the empty container return system.

With the exception of self-appointed, independent agents the warehouses are the only empty container return depots. Therefore any changes to the number or location of warehouse facilities will necessitate changes to the empty container return system if the same number of return depots are to be provided.

All brands and package sizes of bottled and draught beer are stored at each warehouse. In addition, three out-of-province brands are stocked at each warehouse for shipment to liquor vendors and special vendors as required.

The Transportation Network

The transportation network consists of the movement of full goods from the five Saskatchewan breweries to the eight distribution warehouses and from the eight distribution warehouses to about 750 retail outlets.

Shipments from the breweries are primarily by rail in carload quantities. There is daily train service from each brewery to each warehouse with the exception of Weyburn which has train service three days per week. The time in transit seldom exceeds two days; however stock shortages sometimes necessitate the movement of small quantities by truck. As well, for some breweries' products the sales volume is not sufficient to dispose of carload quantities before product age limitations arise. In these cases smaller quantity shipments are made by truck to the warehouse.

Shipment from the warehouses to retail outlets are in smaller quantities and transit time is of more importance since this is an aspect of customer service. These shipments move primarily by truck. Trucking services are offered to all destinations accessible by road by a large number of independent trucking companies and main routes are usually served by several competitive firms. A few locations are served by rail either because of the preferences of the outlet or because the location is only accessible by rail. These are very limited in number. Truck service is daily to most points, however some receive service only every two days.

Transhipments are not made, that is shipments from one warehouse to another, even when emergency shipments are required to prevent an out-of-stock condition.

In Regina, Saskatoon and Prince Albert, where breweries are located, a number of shipments are made to retail outlets direct from the breweries. However, the SBA reports that:

> ...the practise of shipping the local brewery products from the local warehouse is ever increasing because of the revised trucking tariff which is broken down into (1) shipments under 1000 lbs. (2) shipments of 1000 to 2000 lbs. and (3) shipments over 2000 lbs. Another factor is that we can no longer combine shipments from the brewery to a licensee with a shipment from the local warehouse to the same licensee; therefore we are confronted with 2 separate shipments and lower weight per shipment.[21]

As will be pointed out later, the present analysis of the distribution system assumes that all shipments are made from the warehouses since this appears to be the trend and as well, the information available does not provide a method for determining the number or size of shipments made directly from the breweries.

Background to the Problem

As stated previously, the problem posed is essentially one of determining the number, size and location of distribution warehouse facilities. The optimal solution is certainly not clear intuitively and extensive analysis performed to date has not been successful in convincing management of the appropriate course of action.

In 1962 the SBA formed a materials handling committee to study the distribution system and set out recommendations for improved operations and efficiency. In addition to recommending improvements to the methods of handling goods such as palletizing all warehouse facilities, new warehouses were recommended to replace the existing facilities at all sites except Prince Albert. As a result of these

---

[21] Letter from N. Wilken, Warehousing Supervisor, Saskatchewan Brewers' Association Limited, Regina, Saskatchewan, March 6, 1969.

recommendations new warehouse facilities were constructed and in operation at Regina and Saskatoon in August and March of 1965 respectively. The cost to construct and equip these facilities was underestimated by about twenty per cent and as well the anticipated labour savings were not being achieved.

In June 1965 an engineering consulting firm was engaged to study the distribution system with the purpose of determining whether some warehouse facilities could not be eliminated and the method of distribution improved. A containerized system of delivery by SBA-owned and operated trucks and related equipment, termed 'Direct Extended Delivery' was recommended. As well, warehouse facilities were recommended only at Regina, Saskatoon and Prince Albert.

Due to the many intangible factors involved and lack of demonstrated evidence to support the recommendations made, as well as the fact that improved customer service did not appear evident under the proposed system, the SBA directors formed the Saskatchewan Distribution Committee to investigate the recommendations further.

The Saskatchewan Distribution Committee has investigated a number of areas of distribution including the empty container return system, the location of distribution facilities and alternative shipping arrangements such as contract deliveries from central warehouses. To date, the results have been inconclusive in determining the optimum number, size and location of distribution warehouse facilities.

The problem is particularly important since these decisions involve a considerable capital outlay and will determine the network of distribution for many years to come. Heskett and others state:

> Three of the most important internal constraints in terms of their impact on the logistics system, are customer service standards, fixed facility location

and product pricing policy.[22]

Warrack, in a discussion of the location of manufacturing facilities points out that:

> Because of the indivisibilities and time lags, it is difficult to change locations, as a result, location cost advantages may be reaped over long periods of time, and cost savings of only pennies per unit are important.[23]

These comments are certainly applicable to the location of warehouse facilities for Saskatchewan beer distribution.

Many of the current warehouse facilities are in a deteriorated condition and result in inefficient materials handling due to their design. The following list of warehouses by relative priorities from highest to lowest for either reconstruction or discontinued use was prepared by the SBA:

1. North Battleford
2. Yorkton
3. Moose Jaw
4. Weyburn
5. Swift Current

The warehouses located at Regina and Saskatoon are newly constructed while the Prince Albert warehouse is still in relatively good condition.

The concern is primarily with determining which warehouse facilities can be eliminated, if any. Therefore, alternative locations are not investigated in this analysis. Certainly the analysis could be extended

---

22 Op. cit., J. L. Heskett and others.

23 Allan A. Warrack, Cost Analysis in Feed Industry Location, Feedstuffs, Volume 40, Number 39, September 28, 1968, p. 24.

to consider other locations, but the current warehouses are located in the largest population centers in each area and only a very few other centers would be feasible in Saskatchewan where the population is predominately rural.

CHAPTER III

ESTIMATING DISTRIBUTION COSTS

A distribution system is comprised of many components and activities. Physical distribution involves the movement of goods from one or several sources to a single destination or more often many destinations. A destination places a demand on the system for goods and the system responds by initiating activities to meet the demand with a supply of goods from the source. Physical distribution can involve consolidating goods from several sources to meet the requirement and breaking bulk supplies into a size required at the destination. The goods demanded at the destination must be moved from the source of supply through the distribution network to the destination or from some intermediate storage point in the distribution system through the remaining distribution network.

The activities in which a distribution system incurs costs can be identified as the movement of goods to intermediate storage (when intermediate storage facilities exist), the storage of goods (inventory) and the subsequent movement of goods to destinations as required.

These activities take place as a result of demands for goods at destination points. To serve demand a distribution system has at least two important design considerations: (1) the level of service in terms of time and reliability that can be maintained and (2) the cost of providing the service.

When the problem of determining the optimum number, size and location of distribution warehouse facilities (intermediate storage points) is considered the interrelation of all distribution activities

is seen to change as the number, size and location of warehouse facilities change.

Thus, to determine the optimum number, size and location of distribution warehouse facilities all related physical distribution activities must be considered. The objective of minimizing the cost of maintaining a given level of service must relate to the entire distribution system. Underlying this of course is the demand placed on the distribution system for the supply of goods.

This chapter identifies the distribution system components which account for the major portion of the total operating cost affected by the number, size and location of distribution warehouse facilities. Each component is analyzed in an attempt to develop a methodology for estimating cost as the level of activity changes.

The collection of data for the analysis of the Saskatchewan beer distribution system is discussed and the procedure for estimating demand developed and the results presented.

The results of this chapter are then used in Chapter IV to develop a model of the distribution system and analyze the alternate warehouse configurations.

The main cost components of a distribution system consist of transportation costs, warehouse operating costs and inventory carrying costs. The first step must be to give some perspective to these costs in order to determine their relative importance in the distribution system.

Current inventory carrying costs were approximated in the following manner, which although quite imprecise does give an indication of magnitude.

Assuming eighty per cent of the warehouse capacity of 87,135 cases and 4,299 half kegs estimated by the SBA in 1968 was utilized throughout the year and the out-of-pocket cost of full goods was three dollars a case and fifteen dollars a keg[1] then the total value of inventory held would be (69,708 x $3.00 + 3,439 x $15.00) = $260,712.

In practise, considerably less than eighty per cent of the capacity is used on the average. Allowing a cost of capital invested of seven per cent per annum then the cost of carrying inventory is about (260,712 x 7%) = $18,250. In comparison, the cost of operating the eight warehouses is about $600,000, more than double the average value of inventory held. Transportation costs consist of the cost of transpor-
t
tation from the breweries to the warehouses and from the warehouses to retail outlets. Estimating these costs at about $350,000 and $750,000 respectively the total of $1,100,000 is nearly double the cost of operating the warehouses.[2] These approximate costs can be presented as follows:

	Annual Cost 1967-68 approx.	Percentage of Total Cost
Inventory carrying cost	$ 18,000	1.0
Warehouse operating cost	600,000	34.9
Brewery to warehouse shipping cost	350,000	20.4
Warehouse to outlet shipping cost	750,000	43.7
Total	$1,718,000	100.0

---

[1] The out-of-pocket cost is the writer's approximation based on the price paid to the breweries of $3.825 per twenty-four bottle case and $19.110 per half keg.

[2] The warehouse operating costs and transportation costs are approximations made by the writer from information supplied by the Saskatchewan Brewers' Association.

Clearly the emphasis must be placed on the analysis of transportation costs and the warehouse operating costs. Nearly eighty per cent of the warehouse operating cost can be attributed to wages and salaries and as well more than fifty per cent of the total operating cost can be allocated to the handling of empty kegs and returned bottles.

In the absence of economies of scale the expense for wages and salaries will be incurred regardless of the number of facilities established (since the same volume must be handled), thus warehouse operating costs do not represent as important a component as the above estimates first suggest in the solution to the problem of locating warehouse facilities.

Data Collection

The problem of data collection in an analysis of distribution systems is less one of collection than one of selection. Information exists in volume however only certain information is required for solution of the problem being analyzed. Heskett and others state the difficulty clearly that "The greatest deterrent to the effective use of internal company information is the wealth of data available and the wide variety of methods by which it is recorded."[3]

The wealth of information differs in the methods by which its collected and recorded as well as the date and time relationships between recognition as having occurred and when the activity took place. Some information is available in detail and reproduced in several reports while other information is summarized in such a manner

---

[3] J. L. Heskett, Robert M. Ivie, Nicholas A. Slaskowsky Jr., Business Logistics, Management of Physical Supply and Distribution, Ronald Press Company, New York, 1969, p. 473.

that the detail required for this analysis has been lost. Other information is not recorded and its collection could only be accomplished with considerable time and expense.

The principal source of information was the Saskatchewan Brewers' Association Limited (SBA) and reports they had on file from the Brewers' Association of Canada and the Saskatchewan Liquor Control Board.

The location of distribution facilities depends primarily upon the location of sources of supply and demand, volume demanded, transportation rates and cost of establishing and operating the warehouse facilities.

It was decided early in the analysis of the problem that the source of supply could be considered fixed in location and able to supply the volume demanded without delay. Thus the initial data collection was concerned with the location of demand that is, the destinations and the volume demanded.

Each retail outlet in the 1967-1968 fiscal year was recorded according to the type of license, 1) beverage room, 2) beer parlor, 3) dining room, 4) cocktail room, 5) clubs serving both draught and bottled beer, 6) clubs serving only bottled beer, 7) provincial liquor vendors, and 8) special liquor vendors. As well, each oulet location was recorded according to health statistical area and census subdivision.[4] The shipment of half kegs and two dozen cases of bottled beer to each outlet except provincial liquor vendors and special vendors was collected for the fiscal year ended March 31, 1968.

---

[4] Health Statistical Areas and Census Subdivisions are described in the section, Estimating Demand.

All package sizes of bottled beer of six, twelve and twenty-four bottles per package are converted to twenty-four bottle cases in the records of shipments to retail outlets. In addition, the brewery or brand is not recorded for each outlet but only in total by brewery for shipments from warehouse storage.

Draught beer is shipped mainly in half kegs containing 12.5 gallons but some shipments are also made in quarter kegs. Quarter kegs are converted to half kegs in the record of shipments. Similarly to packaged beer, draught beer is recorded only in total by brewery for shipments from warehouse storage.

Some shipments are made directly from the breweries to the retail outlets. Although these are reportedly more infrequent than in past years and are declining, it is not possible to determine the volume shipped in this manner or the type or location of outlets most frequently served in this way.

The shipments to provincial liquor vendors and special vendors was available in total by distribution warehouse for the 1967-1968 fiscal year, but not by individual outlet. The shipments to these outlets for the month of July 1968 was the only data available that would give some indication of the volume shipped to these outlets individually. Thus, in order to approximate the individual shipments for the 1967-1968 fiscal year, the totals by warehouse were allocated to these outlets in each warehouse distribution area on the basis of the July 1968 shipments.

Shipments from the distribution warehouses to retail outlets are made primarily by truck. Since the transportation rates are based on weight and distance, in addition to volume demanded, the mileage

to each outlet from each of the possible warehouse locations was required. The distance from a warehouse to a retail outlet can vary from year to year as new highways are opened, old highways discontinued and trucking routes change correspondingly or in response to the demand for shipment of all kinds of goods between different locations.

Since common carriers are used to ship beer from the warehouses to the retail locations the routes and mileages published for the trucking industry in Saskatchewan for 1968 was used to record the mileage from the eight current warehouse locations to each retail outlet. Since some shipping routes are not given for shipping directly from a warehouse to a retail location it was assumed that the route would be the minimum distance from the warehouse by routing through one of the other warehouse cities to the particular destination. It is recognized that in some instances routes may exist through smaller centers that will be shorter and route changes in the future will be reflected in transportation cost changes. However, changes tend to be minor with the provincial highway system quite complete and the trucking industry well established. The following table shows the mileages between the eight current warehouse locations.

TABLE 1

Tabulated Mileages Between Warehouse Cities

		MJ	SC	WY	YK	RG	SK	PA	NB
Moose Jaw	(MJ)	0	110	93	182[a]	44	139	220	232[b]
Swift Current	(SC)		0	203	292[c]	154	174	272	196
Weyburn	(WY)			0	209[d]	71	231[e]	298[f]	324[g]
Yorkton	(YK)				0	138	208	312[h]	301
Regina	(RG)					0	160	227	253
Saskatoon	(SK)						0	103	93
Prince Albert	(PA)							0	132
North Battleford	(NB)								0

a -- mileage via Regina
b -- mileage via Saskatoon
c -- mileage via Regina
d -- mileage via Regina
e -- mileage via Regina
f -- mileage via Regina
g -- mileage via Regina
h -- mileage via Saskatoon

Source: 1968 Saskatchewan Shippers Guide, Official Guide to Truck and Bus Rates, Volume 19, Mercury Publications Limited, Regina, Saskatchewan, February, 1968.
Official Highway Map, Department of Highways and Transport, Province of Saskatchewan, Regina, Saskatchewan, 1968.

Other information collected and other difficulties encountered in the collection and use of data for the analysis of the Saskatchewan beer distribution system are elaborated upon in the sections which follow.

Estimating Demand

The location of demand and the volume demanded are the main factors influencing the design and operation of a distribution system. Demand permeates the entire system and indeed, that is why the system exists. Ultimately the accuracy of the entire analysis of a distribution system depends upon the accuracy and validity of the data and assumptions made about demand and where it is located.

Demand as it affects the distribution system begins at the retail outlet but demand by the various outlets is derived from the final consumer. Individual decisions regarding the purchase of beer, the type (draught or packaged), the brand, the outlet to purchase from and when to purchase determines the demand of the various outlets.

There are a multitude of interrelated factors affecting decisions in the purchase of beer. Since the interest is in demand at retail outlets on a geographic basis, then the factors of interest are those affecting purchase decisions that can be deliniated geographically and account for significant differences in consumption patterns and the general level of demand.

The dispersion of population accounts primarily for the geographic distribution of demand while age grouping and income accounts for the major portion of the variation in per capita consumption by geographic area.

It was previously stated that disposable income, state of the economy, price of competitive beverages and the weather are the underlying factors affecting per capita consumption. Unfortunately, the behavior of these factors is very difficult to predict. Wide fluctuations in personal disposable income are experienced in Saskatchewan

TABLE 2

CONSUMPTION OF BEER AND PERSONAL DISPOSABLE INCOME FOR THE PROVINCE OF SASKATCHEWAN[a]
1942 - 1962

Year	Beer[b] Consumption	Personal[c] Disposable Income
1942	3.95	$ 631
1943	3.84	495
1944	4.61	762
1945	7.04	605
1946	6.44	739
1947	8.75	721
1948	9.18	888
1949	9.50	913
1950	8.88	814
1951	9.60	1,279
1952	11.06	1,364
1953	11.53	1,246
1954	10.17	861
1955	9.94	1,098
1956	10.22	1,337
1957	10.52	1,078
1958	10.52	1,164
1959	10.29	1,213
1960	11.02	1,384
1961	11.22	1,142
1962	11.42	1,581

a Compiled from Brewers Association of Canada, Brewing In Canada, Ronalds Federated Limited, Montreal, 1965.

b Per Capita consumption in gallons.

c Per Capita personal disposable income in dollars.

TABLE 3

PER CAPITA CONSUMPTION OF BEER BASED ON ADULT POPULATION[a] FOR THE PROVINCE OF SASKATCHEWAN[b] 1956 - 1967

Year	Per Capita[c] Consumption	Percentage Change
1956	16.99	
1957	17.68	4.06
1958	18.17	2.77
1959	17.56	-3.36
1960	18.59	5.87
1961	19.40	4.36
1962	19.70	1.55
1963	20.58	4.47
1964	21.51	4.52
1965	21.81	1.39
1966	22.16	1.60
1967	22.36	.90
Average	19.71	2.56

a Adult population is considered to be all persons 21 years of age or over.

b Source: Brewers Association of Canada Sales Bulletin May 17, 1968.

c Per Capita consumption in gallons.

with good and bad crop years and the ability of the farmers to market their production. The per capita consumption of beer and personal disposable income are shown in Table 2 for Saskatchewan from 1942 until 1962. The correlation between per capita consumption of beer and personal disposable income during this period is 0.82.

Due to an inability to predict the factors underlying per capita consumption changes the average annual rate of increase in per capita consumption based on the adult population and per capita consumption 1956 to 1967 is used to project per capita consumption changes. This data is shown in Table 3.

In order to project demand in a meaningful manner for analysis of a distribution system, the total market must be subdivided into areas small enough to be designated as demand points.

First, the province was divided into fourteen areas corresponding to the Health Statistical Areas used by the Research and Planning Branch of the Department of Public Health in Saskatchewan. As well, the ten largest cities were selected as individual market areas. The twenty-four market areas are listed in Table 4 and the map that follows shows the boundaries with each market area identified by reference number. Next, the province was divided into areas corresponding to the census subdivisisions used for statistical purposes by the Dominion Bureau of Statistics. Each census subdivision measures approximately eighteen to twenty miles square. It will be noted on the map that the census subdivision reference numbers are also shown.

The census subdivisions are small enough to lend themselves to use as a market grid, each census subdivision then being defined as a demand point. This is supported by the fact that in 1967 only fifty-

three of the 313 census subdivisions did not contain a retail outlet selling beer while the other census subdivisions contain only one or two outlets in different locations within a census subdivision.

In almost all cases the retail outlets are concentrated in the same town or city within a census subdivision and the distance between different locations within a census subdivision is at most a few miles. Rivers and other natural barriers are used as boundaries where barriers exist so the route between outlets in the same census subdivision is normally direct.

Although the use of census subdivisions as demand points appears well suited to this analysis, it remains to determine the method to use to project demand in each census subdivision.

When the adult per capita consumption in each census subdivision is calculated it becomes clear that population projections for each census subdivision are of questionable value in projecting demand. The variances are so extreme as to suggest very little relationship between population and beer consumption. The reason of course is undoubtably due to the movement of people to larger centers for the purchase of beer with the result of extremely low per capita purchases in their area of residence and high per capita purchases in the area containing the larger population centers.

The per capita consumption in each market area presents a different result however. The relationship between gallons purchased and adult population is found to vary only slightly between areas. These variances can be assumed to result from the factors mentioned previously such as disposable income, weather conditions and so on.

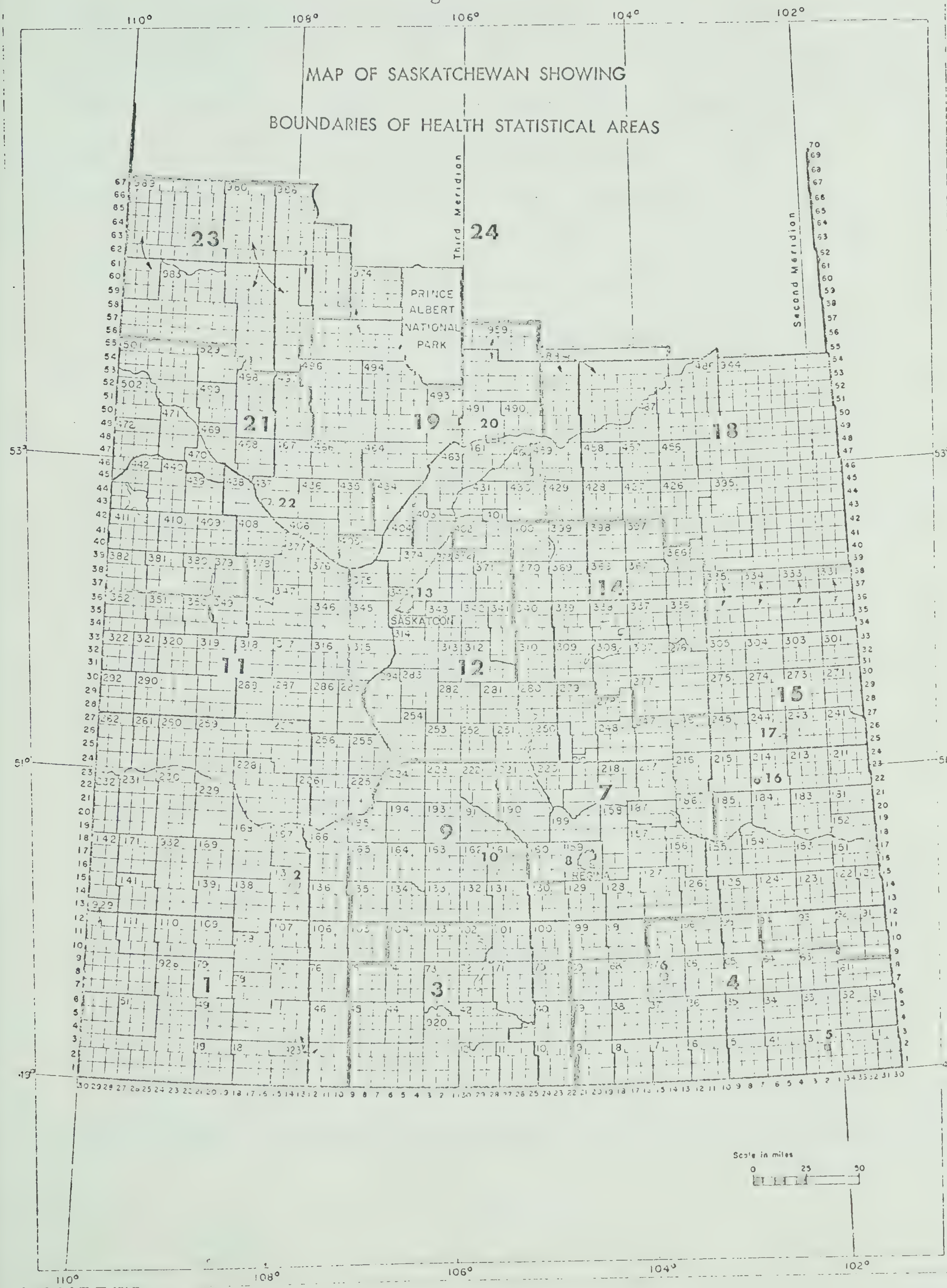
A reasonable basis for determining the demand in each census

TABLE 4

SASKATCHEWAN MARKET AREAS

Reference Number	Area
1	Swift Current Area (excluding Swift Current City)
2	Swift Current City
3	Assiniboia - Gravelbourg Area
4	Weyburn - Estevan Area (excluding Weyburn and Estevan City)
5	Estevan City
6	Weyburn City
7	Regina Rural Area
8	Regina City
9	Moose Jaw Area (excluding Moose Jaw City)
10	Moose Jaw City
11	Rosetown Area
12	Saskatoon Rural Area
13	Saskatoon City
14	Humboldt - Wadena Area
15	Yorkton Area (excluding Yorkton & Melville City)
16	Melville City
17	Yorkton City
18	Melfort - Tisdale Area
19	Prince Albert Area (excluding Prince Albert City)
20	Prince Albert City
21	North Battleford Area (excluding North Battleford City)
22	North Battleford City
23	Meadow Lake Area
24	North Saskatchewan District

Figure 1


MAP OF SASKATCHEWAN SHOWING
BOUNDARIES OF HEALTH STATISTICAL AREAS
110°
108°
106°
104°
102°
53°
51°
49°
Third Meridian
Second Meridian
PRINCE
ALBERT
NATIONAL
PARK
SASKATOON
REGINA
Scale in miles
0
25
50

subdivision, based on the information available, is to project the total gallons demanded in a market area on the basis of the experienced adult per capita consumption and the annual rate of increase in per capita consumption for the province. The projected demand in each market area can then be allocated to each census subdivision in the area in the same proportion as the past sales have been. In the case of ten of the market areas, since they are cities situated in only one census subdivision, all of the projected sales in the market area is allocated to the one census subdivision.

Although this procedure may be deficient in precision it does account for differences in per capita consumption in the twenty-four market areas and assumes that the increase or decline in adult population in a market area will be at the same rate in all census subdivisions within that market area. Since the ten major markets are accounted for separately the results provide accuracy that could only be improved upon by a detailed study of the social and economic development in different areas of each market.

The population projections prepared by the Research and Planning Branch, Saskatchewan Department of Public Health are used to project the demand for beer in gallons for each of the twenty-four market areas. This projection was made using two base years 1966 and 1967 and assumes that the rate of deaths, emigrations, births, immigrations and the ratio of male to female among the newborn will remain constant at the 1967-68 rates. The forward to the report by the Research and Planning Branch states that "No prediction is made in regard to industrial

development or other local specific circumstances."[5]

A projection is made for the years 1968, 69, 70, 71, 72, 77, and 1982. The results of projecting demand in each of the twenty-four market areas is presented in Table 5. The average annual rate of increase in per capita consumption of 2.6 per cent was used.

Demand and sales can be considered as one and the same in this analysis. Since the sales made by the five Saskatchewan breweries constitute the total beer sales in Saskatchewan, with the exception of small quantities that are imported from outside the province, a forecast of demand is a forecast of brewery industry sales.

A forecast of demand in gallons does not complete the demand information required in an analysis of the distribution system. The demand must be allocated to the ultimate sources of supply, the breweries, and identified according to the type of container, brand, package size and so on. However, the ability to do this is seriously hampered by the methods used to record historical sales data. All packaged beer sizes are converted to units of twenty-four dozen bottles and all draught beer into half kegs. As well, different brands are not accounted for separately but recorded only according to brewery. The information is broken down by brewery for each warehouse but recorded only in terms of total cases and kegs for each outlet, thus brewery market share information can only be determined by warehouse.

---

[5] J. D. Ramsay, Saskatchewan Population Projections '67, Research and Planning Branch, Saskatchewan Department of Public Health, Regina, Saskatchewan, 1967.

TABLE 5

DEMAND FORECAST FOR BEER IN SASKATCHEWAN

Market Area	1967 - 1968 Per Capita[a]	1967 - 1968 Total Gallons	1972 - 1973 Per Capita[a]	1972 - 1973 Total Gallons	1977 - 1978 Per Capita[a]	1977 - 1978 Total Gallons	1982 - 1983 Per Capita[a]	1982 - 1983 Total Gallons
1	21.4	509,279	24.3	555,623	27.6	602,762	31.4	645,987
2	29.1	254,217	33.1	335,605	37.6	444,181	42.8	583,553
3	24.1	344,535	27.3	372,546	31.1	398,660	35.3	418,508
4	18.3	422,822	20.8	463,756	23.7	504,039	26.9	538,901
5	30.7	157,950	34.9	229,416	39.7	339,063	45.1	497,112
6	28.1	141,464	32.0	174,547	36.3	220,687	41.3	279,702
7	23.0	1,018,592	26.2	1,162,489	29.7	1,310,785	33.8	1,457,068
8	21.4	1,670,250	24.3	2,285,245	27.6	3,162,678	31.4	4,363,996
9	15.4	181,882	17.5	193,404	19.9	202,899	22.6	206,953
10	26.2	514,779	29.8	587,978	33.9	665,781	38.5	738,703
11	23.0	617,934	26.2	681,047	29.8	742,771	33.9	792,379
12	22.5	553,545	25.6	667,589	29.1	802,400	33.1	958,108
13	22.2	1,545,097	25.2	2,323,636	28.7	3,557,130	32.6	5,457,323
14	25.8	702,140	29.4	792,004	33.4	878,565	37.9	962,752
15	17.0	666,392	19.3	756,157	21.9	848,982	24.9	945,551
16	10.7	84,488	12.2	133,222	13.8	211,462	15.7	331,127
17	61.0	204,361	69.4	255,315	78.9	321,047	89.7	401,248
18	22.3	591,857	25.3	666,318	28.8	739,366	32.7	807,718
19	20.8	488,669	23.6	540,892	26.9	592,857	30.5	642,773
20	31.3	459,988	35.6	635,137	40.4	880,315	46.0	1,217,961
21	19.0	534,596	21.6	600,318	24.6	680,282	28.0	781,119
22	38.7	274,349	44.0	353,407	50.0	459,328	56.9	588,880
23	28.0	167,856	31.8	178,568	36.2	193,837	41.1	210,638
24	18.3	163,256	20.8	247,565	23.7	378,223	26.9	575,227

[a] Based on projected adult population, persons over 20 years of age.

Package size information is not critical to the solution of the problem of locating distribution warehouse facilities except to the extent that it affects the size of facility required. It is known that only a very small fraction of the shipments of draught beer consist of quarter kegs and the shipping cost of bottled beer is not affected by the size of package utilized except to the extent that handling costs in the warehouse may be increased with the use of smaller package sizes.

The type of container, aluminum keg or glass bottle, certainly is important however. The weight per gallon of beer shipped in half kegs is 11.9 pounds per gallon while beer shipped in bottles weighs 17.8 pounds per gallon, nearly one and one half the weight per gallon of beer shipped in half kegs. Table 6 shows the percentage of total gallons sold in draught and packaged for a number of years in Saskatchewan. A trend does not appear to be established in favor of either type of container over the longer period from 1946 to 1967 although the industry generally is of the opinion that recent bottled beer sales are increasing with the opening of more outlets such as cocktail lounges and dining rooms as well as the increase in off premise or home consumption. Changes in the relative price of bottled beer to draught beer is the principal determinant of the type of container demanded and could soon alter any apparent trends. For this reason the 1967-1968 experience is assumed to remain constant for all areas in the province.

The market share for each brewery can be determined on a geographic basis only as a percentage of the total shipments made to each warehouse. As mentioned previously, brewery identification of the products shipped to retail outlets is not retained. Therefore only the record of total

TABLE 6

PERCENTAGE OF TOTAL BEER SALES IN
DRAUGHT AND PACKAGES FOR THE
PROVINCE OF SASKATCHEWAN[a]
1946 - 1967

Year	Percentage Of Total Sales In Draught	In Packages
1946	35.5	64.5
1947	33.6	66.4
1948	30.3	69.7
1949	28.5	71.5
1950	26.1	73.9
1951	35.9	64.1
1952	35.1	64.9
1953	35.3	64.7
1954	40.0	60.0
1955	40.8	59.2
1956	38.6	61.4
1957	40.4	59.6
1958	34.8	65.2
1959	28.1	71.9
1960	22.9	77.1
1961	31.9	68.1
1962	37.4	62.6
1963	37.6	62.4
1964	36.4	63.6
1965	37.0	63.0
1966	35.1	64.9
1967	27.7	72.3

[a] Source: Compiled from Brewers Association of Canada Sales Bulletin May 17, 1968.

cases and kegs shipped to a warehouse from a brewery is available to determine market share on a geographic basis.

If it is assumed that a brewery's share of shipments to a warehouse is distributed evenly throughout the area served by that warehouse then of course the brewery's market share in each census subdivision could be determined by which warehouse served the census subdivision.

This can be an imprecise approximation but it must be noted, the importance of knowing the precise market share in each census subdivision arises when the analysis of warehouse locations introduces less than eight warehouse facilities. If an area served by a facility that was not included in the configuration being analyzed actually had one brewery dominating the market in one area the assumption of an evenly distributed market share would distort the calculation of shipments required from breweries to the warehouse facilities.

Sales of one brewery however are not likely concentrated in any one area to the exclusion of other breweries. Rather, brewery sales are distributed fairly evenly over a market area. Furthermore, the total demand tends to be centered in the larger cities where a warehouse is currently located. The market share by warehouse will therefore tend to be a good measure for that demand center.

The market share for packaged beer and draught beer for each brewery is shown in Table 7 for the 1967-1968 fiscal year. This table was prepared using the assumption outlined above that a brewery's share of shipments to a warehouse is distributed on the same basis to all outlets served by that warehouse.

Since the market share in each area for brewery is determined by many factors including advertising, promotion, public relations and

TABLE 7

BREWERY PERCENTAGE MARKET SHARE BY AREA 1967 - 1968

	Carlings			O'Keefe			Sicks			Molsons			Labatts		
Area	Cse.	Dft.	Gal.	Cse.	Dft.	Gal.	Cse.	Dft.	Gal.	Cse.	Dft.	Gal.	Cse.	Dft.	Gal.
1	13.12	33.75	19.50	5.48	7.55	6.12	43.39	7.82	32.38	23.38	39.51	28.37	14.64	11.37	13.63
2	13.41	33.75	17.50	5.53	7.55	5.94	43.12	7.82	36.02	23.42	39.51	26.66	14.52	11.37	13.89
3	15.77	31.81	17.79	8.48	8.87	8.53	38.13	7.16	34.22	18.37	29.98	19.83	19.25	22.18	19.62
4	14.06	42.26	18.71	7.48	7.07	7.41	38.31	7.32	33.21	20.97	39.60	24.04	19.17	3.75	16.63
5	15.01	42.26	19.41	7.76	7.07	7.65	37.33	7.32	32.49	21.02	39.60	24.02	18.88	3.75	16.44
6	14.71	42.26	18.98	7.67	7.07	7.57	37.65	7.32	32.95	21.00	39.60	23.89	18.97	3.75	16.61
7	18.97	41.31	24.77	6.81	4.70	6.26	35.46	4.49	27.41	20.06	37.93	24.70	18.71	11.57	16.85
8	20.86	44.64	26.05	7.14	2.48	6.12	33.70	2.84	26.96	20.77	39.86	24.94	17.53	10.18	15.92
9	15.42	32.09	18.60	7.68	8.41	7.82	39.16	6.89	33.00	19.31	30.90	21.52	18.43	21.71	19.05
10	16.78	29.15	20.59	9.25	9.84	9.43	37.29	7.11	27.98	17.07	25.08	19.54	19.62	28.82	22.46
11	9.39	5.81	8.12	11.11	37.66	20.51	29.77	11.65	23.36	15.93	4.02	11.71	33.80	40.86	36.30
12	10.04	6.90	9.11	10.86	34.47	17.85	29.92	14.34	25.31	16.14	4.91	12.82	33.04	39.38	34.92
13	10.26	4.12	8.32	12.39	39.62	21.00	27.29	11.22	22.21	14.54	1.98	10.56	35.52	43.06	37.91
14	11.84	6.64	10.17	9.97	28.50	15.91	30.54	20.42	27.30	17.67	11.56	15.71	29.99	32.88	30.91
15	15.20	13.57	14.69	8.24	20.12	11.94	32.87	19.28	28.64	19.53	24.35	21.03	24.16	22.68	23.70
16	15.98	10.25	13.90	8.62	22.01	13.47	32.13	21.04	28.11	19.26	22.69	20.50	24.01	24.02	24.01
17	15.06	10.25	13.46	8.43	22.01	12.93	32.52	21.04	28.71	19.47	22.69	20.54	24.53	24.02	24.36
18	12.38	4.31	9.91	6.88	9.02	7.53	34.55	51.54	39.75	23.97	10.86	19.95	22.23	24.27	22.85
19	11.66	3.91	9.74	7.09	9.70	7.73	34.09	51.52	38.39	23.88	9.66	20.37	23.29	25.21	23.76
20	12.35	3.90	10.31	6.79	8.14	7.12	34.85	53.62	39.39	24.15	10.06	20.75	21.85	24.28	22.44
21	10.44	6.35	9.07	8.41	32.28	16.39	37.26	34.78	36.43	23.32	0.87	15.82	20.57	25.71	22.29
22	11.36	6.80	10.00	7.69	30.82	14.59	38.80	39.47	39.00	25.15	0.65	17.84	16.99	22.26	18.56
23	11.18	6.80	9.62	7.71	30.82	15.91	38.91	39.47	39.11	25.14	0.65	16.45	17.05	22.26	18.90
24	13.89	3.90	12.92	7.10	8.14	7.20	35.30	53.62	37.09	23.24	10.06	21.95	20.47	24.28	20.84
TOTAL	14.27	17.88	15.26	8.43	20.03	11.59	34.20	18.39	29.89	19.90	18.21	19.44	23.20	25.49	23.82

Cse.-bottled beer packaged in cases Dft.-draught beer Gal.-gallons of packaged and draught beer

the introduction of new brands, it is outside the limits of this analysis to project the future market shares. However, changes tend to take place gradually over a number of years. Therefore it is not unreasonable to assume the market shares will remain unchanged without further information and investigation.

Since a distribution system is affected not only by the volume demanded but by when the volume is demanded, it is necessary to be able to describe the seasonality of the market for beer.

The monthly sales of beer in gallons for liquor vendors and for all other outlets was collected for a five year period April 1963 to March 1968. Using the method of least squares a trend line was established and the ratio-to-trend method[6] was employed to calculate the percentage of annual sales for each month of the year for both liquor vendors and for all other outlets. Table 8 presents the results both as a percentage of the annual sales and as a seasonal index with a base of 100.

In summary, the demand for beer (both packaged and draught) in Saskatchewan has been projected on the basis of population projections and the rate of change in per capita consumption in twenty-four market areas. These projections can be allocated to demand points, census subdivisions, on the basis of past sales. As well, the projected demand can be identified as to the source of supply and the seasonal variation by month described.

With this information a model of the system for distributing brewery products in Saskatchewan can be used to analyze the operation of the distribution system in future years.

---

[6] John E. Freud, Frank J. Williams, <u>Modern Business Statistics</u>, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1958, p. 436.

TABLE 8

SEASONAL VARIATION IN BEER SALES
FOR THE PROVINCE OF SASKATCHEWAN

MONTH	LIQUOR VENDORS		OTHER OUTLETS		ALL OUTLETS	
	Percentage	Seasonal Index	Percentage	Seasonal Index	Percentage	Seasonal Index
January	4.13	49.52	5.76	69.07	5.43	65.12
February	5.53	66.31	5.76	69.07	5.75	68.99
March	6.94	83.24	7.45	89.40	7.41	88.91
April	8.04	96.48	7.85	94.21	7.87	94.43
May	8.48	101.72	8.91	106.89	8.75	105.00
June	10.49	125.85	9.90	118.76	10.05	120.59
July	12.26	145.91	11.51	138.09	11.60	139.19
August	10.15	121.85	10.56	126.76	10.48	125.74
September	6.96	83.49	8.36	100.27	8.08	96.96
October	7.64	91.71	8.73	104.78	8.48	101.79
November	7.05	84.60	7.50	89.95	7.49	89.89
December	12.44	149.33	7.73	92.76	8.61	103.38

Transportation Cost Estimate for Shipments from Warehouses to Retail Outlets

The transportation cost for shipments from warehouses to retail outlets is one of the largest cost components in the distribution system. The warehouse to retail outlet transportation costs amount to approximately forty-four per cent of the total cost of operating the distribution system. It is therefore important to develop a method to estimate the transportation cost in order to determine the effect of various warehouse facility configurations.

The principal variables determining the cost of transportation are the following:

1. The class of commodity to be shipped.
2. The mode of transportation to be used.
3. The distance between the supply point and the destination.
4. The transportation rate structure.
5. The weight of each shipment and the number of shipments.

Each of the above variables can be determined in quite a straightforward manner with the exception of the last, the weight of each shipment and the number of shipments.

It will therefore be necessary to depart from the analysis of transportation costs to examine the order frequency of the retail outlets before the methodology can be completed and transportation cost estimates prepared.

First however, the other principal variables listed above determining the cost of transportation will be discussed.

The type of commodity in the case considered is in one transportation commodity class (class 70), irrespective of the type of container (glass bottles or aluminum kegs) or the mode of transportation used

(rail or truck).

The mode of transportation is assumed to be by truck. A small number of shipments from warehouses to retail outlets are made by rail. However, the rate is the same as the truck rate in nearly all such instances.

The distance is given when the supply point (warehouse location) and the demand point or destination (retail outlet) are specified.

The transportation rate structure and regulations pertaining thereto are legally set by the Government of the Province of Saskatchewan for the movement of general merchandise within the province. A basic rate per hundred pounds is set out for the movement of goods from one shipper to one consignee that in the aggregate weighs two thousand pounds or more. Shipments of less than two thousand pounds but in the aggregate of one thousand pounds or more move at the prescribed basic rate plus an additional ten per cent of that rate. Shipments of less than one thousand pounds move at the prescribed basic rate plus an additional fifteen per cent of that rate. However, in 1968 the prescribed rate also specified that shipments of less than fifty pounds move at the one hundred pound, class 100, rate but for not less than \$1.75 and shipments of fifty pounds or more, but less than one hundred pounds move at the one hundred pound class 100 rate, but for not less than \$2.00.

It should be noted that it is advantageous to ship merchandise at a weight greater than actual if a lower shipping rate can be applied that results in a lower total cost. The point at which it becomes advantageous to ship at a nominal weight of one thousand or two thousand pounds to secure a lower rate per hundred pounds is termed the break point.

TABLE 9

CLASS 70 TRUCK RATES[a] FOR SHIPMENTS OF 2,000 POUNDS OR MORE PRESCRIBED BY THE GOVERNMENT OF THE PROVINCE OF SASKATCHEWAN[e]

Mileage[d]	1967[b]	1969[c]	Mileage[d]	1967[b]	1969[c]
20	31	32	260	114	118
30	36	37	270	116	120
40	42	43	280	120	124
50	48	50	290	123	127
60	53	55	300	125	129
70	58	60	310	127	131
80	62	64	320	130	134
90	66	68	330	132	136
100	69	71	340	134	139
110	73	75	350	136	141
120	77	80	360	138	143
130	80	83	370	140	145
140	83	86	380	143	148
150	86	89	390	145	150
160	89	92	400	148	153
170	92	95	410	150	155
180	95	98	420	152	157
190	97	100	430	155	160
200	99	102	440	157	162
210	102	105	450	159	164
220	104	108	460	161	166
230	106	110	470	163	169
240	109	113	480	165	171
250	112	116	490	167	173
			500	170	176

a In cents per hundred pounds.

b Prescribed November 17, 1967.

c Prescribed February 14, 1969.

d If the exact distance is not listed, the next higher mileage rate applies.

e Prepared from the Saskatchewan Shippers Guide, Mercury Publications Limited, Regina Saskatchewan, Volume 19 (20), February 1968, (February 1969), pp. 66-7, (pp. 67-8).

Table 9 that follows contains the prescribed rates in effect for 1967, 1968 and 1969.

Shipments within the same city are set by negotiation with the transport companies offering a local delivery service. The rate schedule shown in Table 10 for intra-city shipments does not contain weight categories, but they are quoted per hundred pounds irrespective of the total shipping weight.

TABLE 10

Intra-City Shipping Rates Effective for the

Fiscal Year Ended March 31, 1968

(Rates in cents per hundred pounds)

City	Rate
Moose Jaw	12.5
Swift Current	12.5
Yorkton	12.5
Regina	16.25
Saskatoon	12.5
Prince Albert	12.5
North Battleford	12.5

Source: Saskatchewan Brewers' Association Limited, Regina, Saskatchewan.

The weight of each shipment is determined by the individual retail outlet and is a function of the following factors:

1. Type of outlet, beverage room, beer parlor, dining room, cocktail room, club, liquor vendor and so on.
2. Type of market served.
3. Sales variation experienced with the day of the week and month of year.

4. Annual volume sold.

5. Distance from the supplying warehouse and the associated shipping lead time.

6. Facilities for storage of draught and bottled beer.

7. Ability to finance inventories.

8. Age limitations of the product.

9. Impending price changes and other factors.

The actual order size or order frequency experienced by type of outlet is not available and it is nearly impossible to account for all the influencing factors. However, it must be kept in mind that the purpose of determining the order size or weight of each shipment is to determine whether goods will move in the rate category of under one thousand pounds, over one thousand but less than two thousand, or over two thousand pounds. Since the most expensive rate is fifteen per cent greater than the least expensive rate, cognance must be given to order size. However, the importance of accuracy can only be determined from an analysis of the effect of varying the order size or order frequency.

The total shipments made to each outlet in the fiscal year April 1, 1967 to March 31, 1968 were recorded as well as the type of outlet by license category and the mileage to the supplying warehouse. Using the transportation rate structure presented earlier in Table 9, calculating a measure of monthly seasonal variation, introducing various order frequencies and calculating the resulting annual transportation cost reveals the degree to which the cost of transportation responds to changes in order size.

An examination of the percentage of total shipments made through

TABLE 11

SHIPMENTS OUT OF WAREHOUSE STORAGE AS A PERCENTAGE OF TOTAL SHIPMENTS BY WEIGHT FOR THE FISCAL YEAR ENDED MARCH 31, 1968[a]

WAREHOUSE LOCATION	AVERAGE PERCENTAGE		DIFFERENCE BETWEEN HIGHEST AND LOWEST MONTHLY PERCENTAGE	
	Draught	Packaged	Draught	Packaged
Moose Jaw	6.59	7.51	1.21	.85
Swift Current	7.16	7.22	.91	.79
Weyburn	3.83	7.91	1.14	.95
Yorkton	12.29	9.79	1.33	1.33
Regina	18.69	23.07	3.39	2.69
Saskatoon	29.13	23.46	3.94	1.64
Prince Albert	13.13	13.99	3.39	1.64
North Battleford	8.98	7.05	1.21	1.38
TOTAL	100.00	100.00		

[a] Prepared from reports of the Saskatchewan Brewers' Association Limited.

TABLE 12

SEASONAL VARIATION OF BEER SHIPMENTS TO OUTLETS IN SASKATCHEWAN
APRIL 1, 1967 TO MARCH 31, 1968[a]

(PERCENTAGE BY MONTH)

Month	Cases Shipped To Liquor Vendors	Cases Shipped To Outlets[b]	Halves Shipped To Outlets[b]
April 1967	6.1	6.3	8.7
May 1967	8.3	8.5	9.4
June 1967	10.2	10.2	10.2
July 1967	11.5	10.9	9.7
August 1967	11.9	10.8	9.9
September 1967	7.7	9.0	8.3
October 1967	7.8	8.4	7.9
November 1967	6.8	7.9	7.7
December 1967	12.1	7.5	7.6
January 1968	4.7	6.1	6.5
February 1968	6.0	6.8	6.9
March 1968	6.9	7.6	7.2
TOTAL	100.0	100.0	100.0

[a] Calculated from reports prepared by the Saskatchewan Brewers' Association Limited.

[b] All outlets excluding liquor vendors and special vendors.

each warehouse by month indicates that seasonal variation tends to affect the province very nearly equally in all areas. It appears that any differences are due to local conditions such as the weather and local holidays or special events. This is presented in Table 11.

Therefore a measure of seasonal variation by month for the entire province is felt to be adequate in describing the variation experienced in any geographic area. This is presented in Table 12 for the fiscal year 1967-1968.

As mentioned at the outset of this section a departure must be made at this point to examine the order frequency of the retail outlets before the development of the methodology for estimating warehouse to retail outlet transportation costs can proceed. The completed results of the estimated transportation cost for shipping from warehouses to retail outlets follows the analysis of order frequency.

Analysis of Order Frequency

The analysis of order size can be approached in two ways. It can be assumed that the elapsed time between orders (order frequency) is fixed and the order size is permitted to vary throughout the year as sales follow a seasonal variation. The other approach is to assume the order size remains constant and the elapsed time between orders varies. In practise both the order size and the order frequency are allowed to vary.

At the warehouse these changes are experienced as fewer orders and smaller orders in the low volume months like January and many orders and larger orders in July and August, the peak volume months. Thus the order size and number of orders tend to vary together.

In this analysis the order frequency was assumed to be constant for the year and the order size allowed to increase and decrease with the monthly variation in sales. The analysis was done for constant order frequencies of one through fifteen orders per month for each type of outlet and each warehouse.

The following summarizes the procedure employed:

1. Each outlet of a particular type was assigned to the warehouse reported by the SBA to have supplied it during the fiscal year ended March 31, 1968.
2. The shipments of cases and kegs to an outlet for each month of the fiscal period were calculated using the measure of monthly seasonal variation as outlined in Table 8 and the actual annual shipments made to each outlet during the fiscal year ended March 31, 1968.
3. The total weight shipped each month was calculated.
4. Using the total weight shipped each month and a constant order frequency the average weight per shipment each month was calculated.
5. The transportation rate shown in Table 9 effective November 1967 was determined from the mileage between the retail outlet and the supplying warehouse, then adjusted as necessary for each month according to the average weight per shipment each month and the break point. Since deliveries to retail outlets in the same city as a warehouse are at a constant rate per hundred, intra-city shipments were accumulated separately.
6. The shipping cost was then calculated and accumulated for each retail outlet type and each warehouse.

Proceeding in the above manner for all outlets the annual shipping costs were accumulated for each warehouse by type of outlet with the order frequency held constant at one order per month to fifteen orders per month. The results are outlined in the following tables.

The variation in transportation cost as the order frequency changes is clearly less than the maximum possible differential of fifteen per cent provided for in the transportation rate structure. This can be explained by the fact that some outlets are in the under one thousand pounds per shipment category even at one order per month while many of the larger volume outlets continue to have all orders over two thousand pounds even at ten and fifteen orders per month.

The results of varying the order frequency demonstrate that all warehouse locations are affected about the same as shown in Table 13. Differences of course are due to the higher proportion of some outlet types served by some warehouses than are served by other warehouses as well as the differences in average volume served by outlet types in different areas of the province.

The total cost of shipping to outlets outside warehouse cities can be accounted for from an examination of Table 14. At the minimum cost shown, beverage rooms account for 88.0 per cent of the total cost, liquor vendors 7.3 per cent, beer parlors 3.2 per cent, special vendors 0.8 per cent, clubs not serving draught 0.4 per cent, clubs serving draught 0.3 per cent, cocktail rooms 0.1 per cent and dining rooms 0.1 per cent.

The result of varying the order frequency affects dining rooms and cocktail rooms the least. In fact the effect is negligible when it is considered that dining rooms and cocktail rooms account for only

TABLE 13

ESTIMATED TRANSPORTATION COSTS FOR SHIPMENTS FROM WAREHOUSES TO RETAIL OUTLETS
FOR THE FISCAL YEAR ENDED MARCH 31, 1968 BY WAREHOUSE LOCATION

TRANSPORTATION COSTS FOR SHIPMENTS TO OUTLETS OUTSIDE WAREHOUSE CITIES

Monthly Order Frequency	Moose Jaw	Swift Current	Weyburn	Yorkton	Regina	Saskatoon	Prince Albert	North Battleford	Total
1	39,170	64,553	66,384	110,483	101,015	141,131	113,572	68,135	704,443
2	39,194	64,634	66,494	110,589	101,022	141,198	113,691	68,178	705,000
3	39,251	64,777	66,620	110,783	101,089	141,294	113,879	68,306	705,999
4	39,303	64,969	66,734	111,088	101,231	141,717	114,315	68,506	707,863
5	39,457	65,267	66,926	111,593	101,582	142,487	115,021	68,875	711,206
6	39,701	65,565	67,183	112,344	102,028	143,530	115,722	69,310	715,383
7	39,953	65,897	67,485	113,184	102,561	144,564	116,365	69,779	719,788
8	40,306	66,330	67,872	114,021	103,240	145,572	116,994	70,203	724,538
9	40,785	66,934	68,296	114,805	103,950	146,573	117,633	70,679	729,659
10	41,208	67,574	68,763	115,503	104,707	147,582	118,215	71,176	734,728
11	41,605	68,189	69,195	116,207	105,502	148,649	118,820	71,709	739,876
12	41,945	68,817	69,686	116,920	106,318	149,599	119,407	72,238	744,928
13	42,324	69,305	70,167	117,613	106,948	150,598	119,942	72,744	749,641
14	42,523	69,738	70,539	118,259	107,502	151,404	120,394	73,128	753,567
15	42,736	70,140	70,967	118,912	108,232	152,170	120,929	73,548	757,634

TRANSPORTATION COST FOR SHIPMENTS TO OUTLETS IN WAREHOUSE CITIES

Moose Jaw	Swift Current	Weyburn	Yorkton	Regina	Saskatoon	Prince Albert	North Battleford	Total
10,308	5,290	2,990	3,754	44,876	30,822	9,438	5,697	113,175

TABLE 14

ESTIMATED TRANSPORTATION COSTS FOR SHIPMENTS FROM WAREHOUSES TO RETAIL OUTLETS
FOR THE FISCAL YEAR ENDED MARCH 31, 1968 BY TYPE OF OUTLET

TRANSPORTATION COSTS FOR SHIPMENTS TO OUTLETS OUTSIDE WAREHOUSE CITIES

Monthly Order Frequency	OUTLET TYPES Beverage Rooms	Beer Parlors	Dining Rooms	Cocktail Rooms	Clubs (With Draught)	Clubs (Without Draught)	Liquor Vendors	Special Vendors	Total
1	619,595	22,248	378	461	1,876	2,511	51,047	6,327	704,443
2	619,674	22,312	386	468	1,915	2,609	51,149	6,487	705,000
3	620,003	22,377	389	468	1,935	2,656	51,479	6,692	705,999
4	621,041	22,489	389	468	1,982	2,701	51,970	6,823	707,863
5	623,422	22,619	389	468	2,034	2,749	52,554	6,971	711,206
6	626,701	22,753	389	468	2,056	2,778	53,196	7,042	715,383
7	630,418	22,834	389	468	2,089	2,789	53,732	7,069	719,788
8	634,540	22,948	389	468	2,102	2,797	54,195	7,099	724,538
9	638,984	23,084	389	468	2,111	2,810	54,654	7,159	729,659
10	643,455	23,211	389	468	2,130	2,817	55,090	7,168	734,728
11	648,047	23,338	389	468	2,136	2,822	55,498	7,178	739,876
12	652,624	23,428	389	468	2,139	2,834	55,862	7,184	744,928
13	657,052	23,531	389	468	2,148	2,834	56,035	7,184	749,641
14	660,716	23,601	389	468	2,150	2,834	56,222	7,187	753,567
15	664,569	23,636	389	468	2,150	2,834	56,400	7,188	757,634

TRANSPORTATION COST FOR SHIPMENTS TO OUTLETS IN WAREHOUSE CITIES

Beverage Rooms	Beer Parlors	Dining Rooms	Cocktail Rooms	Clubs (With Draught)	Clubs (Without Draught)	Liquor Vendors	Special Vendors	Total
83,752	73	207	1,274	2,245	1,122	24,502	0	113,175

TABLE 15

ESTIMATED TRANSPORTATION COSTS FOR SHIPMENTS FROM WAREHOUSES TO RETAIL OUTLETS FOR THE FISCAL YEAR ENDED MARCH 31, 1968 EXPRESSED AS A PERCENTAGE OF THE MAXIMUM COST ESTIMATED FOR SHIPMENTS TO OUTLETS OUTSIDE WAREHOUSE CITIES BY WAREHOUSE LOCATION

Monthly Order Frequency	Moose Jaw	Swift Current	Weyburn	Yorkton	Regina	Saskatoon	Prince Albert	North Battleford	Total
1	92	92	94	93	93	93	94	93	93
2	92	92	94	93	93	93	94	93	93
3	92	92	94	93	93	93	94	93	93
4	92	93	94	93	94	93	95	93	93
5	92	93	94	94	94	94	95	94	94
6	93	93	95	94	94	94	96	94	94
7	93	94	95	95	95	95	96	95	95
8	94	95	96	96	95	96	97	95	96
9	95	95	96	97	96	96	97	96	96
10	96	96	97	97	97	97	98	97	97
11	97	97	98	98	97	98	98	97	98
12	98	98	98	98	98	98	99	98	98
13	99	99	99	99	99	99	99	99	99
14	100	99	99	99	99	99	100	99	99
15	100	100	100	100	100	100	100	100	100

TABLE 16

ESTIMATED TRANSPORTATION COSTS FOR SHIPMENTS FROM WAREHOUSES TO RETAIL OUTLETS FOR THE FISCAL YEAR ENDED MARCH 31, 1968 EXPRESSED AS A PERCENTAGE OF THE MAXIMUM COST ESTIMATED BY TYPE OF OUTLET

Monthly Order Frequency	Beverage Rooms	Beer Parlors	Dining Rooms	Cocktail Rooms	Clubs (With Draught)	Clubs (Without Draught)	Liquor Vendors	Special Vendors	Total
1	93	94	97	98	87	89	91	88	93
2	93	94	99	100	89	92	91	90	93
3	93	95	100	100	90	94	91	93	93
4	93	95	100	100	92	95	92	95	93
5	94	96	100	100	95	97	93	97	94
6	94	96	100	100	96	98	94	98	94
7	95	97	100	100	97	98	95	98	95
8	95	97	100	100	98	99	96	99	96
9	96	98	100	100	98	99	97	100	96
10	97	98	100	100	99	99	98	100	97
11	98	99	100	100	99	100	98	100	98
12	98	99	100	100	99	100	99	100	98
13	99	100	100	100	100	100	99	100	99
14	99	100	100	100	100	100	100	100	99
15	100	100	100	100	100	100	100	100	100

about 0.1 per cent of the total cost shown in Table 14.

Clubs, with and without draught facilities appear to be quite sensitive to changes in the order frequency. At one order per month the cost is only eighty-seven per cent of the cost of fifteen orders per month.

Similarly to clubs, special vendors appear to be quite sensitive to change in the order frequency. However clubs and special vendors represent only 1.4 per cent of the total cost shown in Table 14 and the difference between one order and fifteen orders per month is only 0.2 per cent of the total minimum cost shown.

Beverage rooms, beer parlors and liquor vendors represent 98.5 per cent of the minimum total transportation cost. Although they are not quite as sensitive to changes in the order frequency as clubs or special vendors the effect on total cost is certainly greater. The difference between one order and fifteen orders per month is 7.4 per cent of the total minimum cost shown.

Discussion with officials of the Saskatchewan Brewers' Association suggested the probable range of order frequency for beverage rooms and beer parlors to be between once per week to about three orders per week. It is recognized that there are some exceptions to this due to the factors previously presented that affect order size and as well the practise of some hotels to place the orders for the beverage room, dining room and cocktail room at the same time. Since the orders are made up together and are shipped to one consignee the applicable rate is determined from the combined weight.

The probable order frequency for liquor vendors was suggested to be about once to twice per week. In the case of clubs,those serving

draught are usually in operation throughout the year, ordering about once per week. Clubs serving only bottled beer are often in operation only seasonally (i.e. golf clubs, curling clubs) and order about once per week while in operation (the analysis assumed continuous operation).

On the basis of the discussions with the SBA officials and the results of the order frequency analysis the following order frequencies were developed for use in subsequent analysis.

TABLE 17

Type of Outlet	Order Frequency per Month
Beverage rooms	8
Beer parlors	8
Dining rooms	1
Cocktail rooms	1
Clubs (with draught facilities)	4
Clubs (without draught facilities)	1
Liquor vendors	6
Special vendors	4

The estimated transportation cost for the fiscal year ended March 31, 1968 based on these order frequencies is presented in Table 18. The actual transportation costs incurred for shipments from the warehouses to the retail outlets could not be provided by the SBA for comparison. Thus, evidence to support the procedure employed cannot be presented. Some caution must therefore be exercised in any interpretation of these estimates. Since the transportation rate structure used is that presented in Table 9 effective November 1967, the actual rate structure in effect during the fiscal year prior to November would have been about two per cent less. When we consider that about sixty-four per cent of the annual shipments were made prior to November then an actual cost of about 1.3 per cent less than the

TABLE 18

ESTIMATED TRANSPORTATION COSTS FOR SHIPMENTS FROM WAREHOUSES TO RETAIL OUTLETS
FOR THE FISCAL YEAR ENDED MARCH 31, 1968[a]

TRANSPORTATION COST TO OUTLETS OUTSIDE WAREHOUSE CITIES

Outlet Type[b]	Moose Jaw	Swift Current	Weyburn	Yorkton	Regina	Saskatoon	Prince Albert	North Battleford	Total
Beverage Rooms	35,082	58,018	61,972	102,753	95,749	125,803	93,010	62,154	634,541
Beer Parlors	-	2,756	-	691	1,086	5,811	11,839	765	22,948
Dining Rooms	99	65	24	168	-	-	14	8	378
Cocktail Rooms	64	15	-	194	-	129	59	-	461
Clubs-With Draught	-	-	-	285	-	1,485	-	211	1,981
Clubs-Without Draught	-	166	881	-	14	183	1,171	96	2,511
Liquor Vendors	3,474	4,116	4,532	8,656	6,247	10,623	10,115	5,433	53,196
Special Vendors	1,440	1,089	306	1,001	-	1,109	517	1,360	6,822
Total	40,159	66,225	67,715	113,748	103,096	145,143	116,725	70,027	722,838

TABLE

TRANSPORTATION COST TO OUTLETS IN WAREHOUSE CITIES

Outlet Type[b]	Moose Jaw	Swift Current	Weyburn	Yorkton	Regina	Saskatoon	Prince Albert	North Battleford	Total
Beverage Rooms	7,491	4,401	2,512	2,894	31,792	22,356	7,909	4,397	83,752
Beer Parlors	-	-	-	73	-	-	-	-	73
Dining Rooms	12	-	12	18	20	129	10	6	207
Cocktail Rooms	39	34	-	22	892	215	45	27	1,274
Clubs-With Draught	924	81	-	326	539	-	304	71	2,245
Clubs-Without Draught	40	78	90	-	880	-	33	1	1,122
Liquor Vendors	1,802	696	376	421	10,753	8,122	1,137	1,195	24,502
Special Vendors	-	-	-	-	-	-	-	-	-
Total	10,308	5,290	2,990	3,754	44,876	30,822	9,438	5,697	113,175

Warehouse Totals	Moose Jaw	Swift Current	Weyburn	Yorkton	Regina	Saskatoon	Prince Albert	North Battleford	Total
	50,467	71,515	70,705	117,502	147,972	175,965	126,163	75,724	836,013

Outlet Type Totals	Beverage Rooms	Beer Parlors	Dining Rooms	Cocktail Rooms	Clubs With Draught	Clubs Without Draught	Liquor Vendors	Special Vendors	Total
	718,293	23,021	585	1,735	4,226	3,633	77,697	6,822	836,013

[a] All shipments are assumed to be made from a warehouse.

[b] The following monthly order frequencies are assumed, Beverage Rooms-8, Beer Parlors-8, Dining Rooms-1, Cocktail Rooms-1, Clubs With Draught-4, Clubs Without Draught-1, Liquor Vendors-6, Special Vendors-4.

estimate in Table 18 is likely more accurate. As well, the method used to determine liquor vendor and special vendor annual shipments obviously is a source of some inaccuracy as well as lack of information on any special shipping arrangements such as retail outlets taking delivery at the warehouse or brewery.

The method used to estimate these costs is adequate for the purposes of subsequent analysis in the location of warehouse facilities for several reasons. Perhaps most importantly, with the information available, little more can be done to refine the method used. Also, in subsequent analysis, the transportation rates can be revised upward and downward to reveal the degree of sensitivity of the solution to error in transportation cost estimates and changes in the transportation rate structure.

Transportation Cost Estimate for Shipments from Breweries to Warehouse Facilities

A method has been developed for estimating the cost for shipping from warehouses to retail outlets. The section of the transportation system remaining must now be analyzed.

The transportation cost estimate for shipments from breweries to warehouse facilities accounts for approximately twenty per cent of the distribution system cost. While this is less than half the cost of shipping from warehouses to retail outlets it is an essential part of the total distribution system and subject to considerable change as the system of warehousing is changed. Therefore it is important to develop a method to estimate the transportation cost for shipments from breweries to warehouses in order to determine the effect of

various warehouse facility configurations.

As previously stated, the principal factors determining the cost of transportation are:

1. The class of commodity.

2. The mode of transportation.

3. The distance between the source and the destination.

4. The transportation rate structure.

5. The weight and number of shipments to be made.

Again, as in shipments from warehouses to retail outlets, the commodity is in one transportation commodity class, irrespective of the type of container.

The mode of transportation is assumed to be by rail. The bulk of the shipments are made by rail at carload rates but the low volume shipped from some breweries to certain warehouses does result in a number of less than carload rail shipments as well as some shipments by truck. Furthermore, unexpected increases in sales can result in the requirement for fast delivery of some products by truck. For the most part, the number of less than carload rail shipments and truck shipments is determined by the inventory stocking policy in effect at each warehouse and the unexpected variations in sales. Since less than carload and truck shipments are infrequent and an accurate estimate could only be made after extensive analysis of the inventory stocking policy and sales variations it is assumed that all shipments are made by rail in carload quantities.

The rate structure presented in Table 19 accounts for the distance between each brewery and each warehouse location.

The railway rate structure is determined by negotiation for the

TABLE 19

AGREED RAILWAY FREIGHT RATES EFFECTIVE JANUARY 1, 1967 FOR THE SHIPMENT OF DRAUGHT AND BOTTLED BEER FROM THE FIVE SASKATCHEWAN BREWERIES TO THE EIGHT WAREHOUSE STORAGE LOCATIONS IN THE PROVINCE OF SASKATCHEWAN

(RATES IN CENTS PER HUNDRED POUNDS, CARLOAD MINIMUM WEIGHT IN THOUSANDS OF POUNDS)

	From Regina (Carling's and Molson's) Carload Weight					From Saskatoon (O'Keefe's and Labatt's) Carload Weight					From Prince Albert (Sicks') Carload Weight				
To Location	30	40	50	60	70	30	40	50	60	70	30	40	50	60	70
Moose Jaw	17	15	14	13	13	26	24	22	20	19	37	34	32	30	28
Swift Current	26	24	22	20	19	31	28	25	23	22	40	36	34	32	30
Weyburn	21	19	17	15	15	35	32	30	28	26	46	43	40	37	35
Yorkton	28	24	22	20	19	33	31	28	25	24	37	34	32	30	28
Regina	16	16	16	16	16	28	25	23	21	20	35	32	30	28	26
Saskatoon	28	25	23	21	20	11	11	11	11	11	23	21	20	19	18
Prince Albert	35	32	30	28	26	23	21	20	19	18	11	11	11	11	11
North Battleford	37	34	32	30	28	23	21	20	19	18	26	24	22	20	19

TABLE 20

AGREED RAILWAY FREIGHT RATES EFFECTIVE MAY 19, 1969 FOR THE SHIPMENT OF DRAUGHT AND BOTTLED BEER FROM THE FIVE SASKATCHEWAN BREWERIES TO THE EIGHT WAREHOUSE STORAGE LOCATIONS IN THE PROVINCE OF SASKATCHEWAN

(RATES IN CENTS PER HUNDRED POUNDS, CARLOAD MINIMUM WEIGHT IN THOUSANDS OF POUNDS)

	From Regina (Carling's and Molson's) Carload Weight					From Saskatoon (O'Keefe's and Labatt's) Carload Weight					From Prince Albert (Sicks') Carload Weight				
To Location	30	40	50	60	70	30	40	50	60	70	30	40	50	60	70
Moose Jaw	19	16	15	14	14	29	26	24	21	20	41	37	35	32	29
Swift Current	29	26	24	21	20	34	30	27	24	23	44	39	37	34	32
Weyburn	23	21	18	16	16	39	35	32	29	27	51	46	43	39	37
Yorkton	31	26	24	21	20	36	33	30	26	25	41	37	35	32	29
Regina	16	16	16	16	16	31	27	25	22	21	39	35	32	29	27
Saskatoon	31	27	25	22	21	11	11	11	11	11	25	23	22	20	19
Prince Albert	39	35	32	29	27	25	23	22	20	19	11	11	11	11	11
North Battleford	41	37	35	32	29	25	23	22	20	19	29	26	24	21	20

TABLE 21

COMPARISON OF RAILWAY CARLOAD SHIPPING RATES AND TRUCK SHIPPING RATES FOR SHIPMENTS FROM BREWERIES TO WAREHOUSES IN THE PROVINCE OF SASKATCHEWAN JANUARY, 1967

(RATES IN CENTS PER HUNDRED POUNDS)

To Warehouse Location	From Regina Carload Rate[a]	Truck Rate[b]	From Saskatoon Carload Rate[a]	Truck Rate[b]	From Prince Albert Carload Rate[a]	Truck Rate[b]
Moose Jaw	17	42	26	80	37	104
Swift Current	26	86	31	92	40	116
Weyburn	21	58	35	106	46	123
Yorkton	28	80	33	99	37	127
Regina	16	16.25	28	89	35	104
Saskatoon	28	89	11	12.5	23	69
Prince Albert	35	104	23	69	11	12.5
North Battleford	37	112	23	66	26	80

[a] The carload rate is based on a shipment of thirty thousand pounds or more, but less than forty thousand pounds.

[b] The truck rate is based on a shipment of two thousand pounds or more.

movement of beer from breweries to warehouses. The rates are set with the agreement that ninety per cent of all shipments made to the warehouses will move by rail. Each rate is based on a certain weight per carload as set out in Tables 19 and 20. In practise only the weight of full goods is included in calculating the shipping weight; tarps, pallets, empty cartons and so on are not inculded.

For purposes of comparison Table 21 presents the maximum carload rate per hundred pounds for shipments of thirty thousand pounds or over but less than forty thousand pounds and the rate per hundred pounds for shipments by truck of over two thousand pounds. The carload railway rate is only about one third as much as the less than carload or truck rate. When the magnitude of the shipping cost is considered in relation to the other distribution system costs it is difficult to visualize where savings would be incurred to justify the increased cost of shipping in less than carload lots.

The weight of each shipment depends upon the manner in which pallets are made up, the number of pallets that can be accommodated in a railway car and of course the volume to be shipped. As well, the number of pallets of bottled beer and draught beer comprising the load influences the total carload weight. Currently bottled beer is stacked on pallets measuring thirty-eight inches by forty-eight inches empty and thirty-nine inches by fifty-one inches loaded. The bottled beer is stacked eight cases high and consists of one hundred and sixty dozen per pallet, usually of a uniform package size and brand. Bottled beer weighs sixteen pounds per dozen.

Draught beer in twelve and one half gallon kegs is loaded six kegs

to a pallet (of the same size as above), each full keg weighing one hundred and forty-nine pounds.

The railway cars measure forty feet six inches in length, eight feet nine inches in width and nine feet eight inches in height. Thus, a maximum of twenty-four pallets can be placed on the floor of the car. Draught beer can be stacked two pallets high,however pallets of bottled beer cannot be stacked two high unless the pallets are restricted to a seven case height (one hundred and forty cases per pallet).

Since every warehouse and brewery is not equipped with pallet handling equipment the stacking of pallets two high has not been extensive.

The procedure employed to estimate the cost of transportation from breweries to warehouses can be summarized as follows:

1. Each outlet was assigned to the warehouse reported by the SBA to have supplied it during the fiscal year ended March 1968.
2. The shipments of cases and kegs to outlets were accumulated for each warehouse according to the warehouse supplying the outlet.
3. The time and volume of shipments made to each warehouse was assumed to correspond to the time and volume of shipments made from each warehouse to retail outlets. Thus, using the measure of seasonal variation outlined earlier in Table 8 and the quantity of cases and kegs accumulated above the shipments to each warehouse by month were calculated. In practise the seasonal variation in shipments to the warehouses from the breweries would lead the seasonal variation in retail sales.

4. The SBA was able to supply information on each brewery's percentage of the total shipments from each warehouse to retail outlets by month for cases and kegs. Using this market share information for each brewery during the 1967-1968 fiscal year by month for each warehouse, the shipments of cases and kegs from each brewery to each warehouse were calculated for each month.
5. The carload maximum was assumed to be twenty-four pallets, consisting of either eighty cases of two dozen each per pallet or six kegs of twelve and one half gallons per pallet. Furthermore, it was assumed that a carload could be comprised of any combination of pallets of cases and kegs.
6. Using the estimated volume shipped (4 above) and carloading assumption (5 above) the number of carload shipments were calculated for each brewery to each warehouse by month.
7. Calculating the total weight shipped to a warehouse from a brewery from the volume shipped (4 above) and dividing by the number of carloads (6 above) the average weight per carload was determined by month.
8. Using the freight rates applicable to the 1967-1968 fiscal year for shipments from breweries to warehouses and determining the carload weight category from the average weight per carload shipment (7 above) the cost of shipping from each brewery to each warehouse was calculated by month.

The resulting annual costs are presented in Table 22. Since there were a large number of orders from retail outlets filled at the breweries a substantial volume of the shipments did not incur the

TABLE 22

ESTIMATED BREWERY TO WAREHOUSE TRANSPORTATION COSTS
FOR THE FISCAL YEAR ENDED MARCH 31, 1968

ASSUMING BOTTLED BEER OF TWENTY FOUR EIGHTY CASE PALLETS AND
DRAUGHT BEER OF TWENTY FOUR SIX KEG PALLETS PER CARLOAD

Warehouse Location	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's	Total
Moose Jaw	4,211	3,130	14,509	4,028	7,404	33,282
Swift Current	6,095	2,338	17,004	9,092	5,219	39,748
Weyburn	4,608	3,074	18,751	5,933	7,059	39,425
Yorkton	6,487	7,630	20,112	9,822	15,108	59,159
Regina	16,782[a]	6,104	36,829	16,288[a]	16,675	92,678
Saskatoon	9,574	9,725[a]	23,039	12,980	19,581[a]	74,899
Prince Albert	8,439	3,938	11,222[a]	17,186	12,538	53,323
North Battleford	4,895	4,373	13,375	8,237	5,760	36,640
Total Cost	61,091	40,312	154,841	83,566	89,344	429,154
Less Intra-City Costs	16,782	9,725	11,222	16,288	19,581	73,598
	44,309	30,587	143,619	67,278	69,763	355,556
Less Actual Cost	42,353	35,001	151,476	72,668	70,541	372,039
Difference	1,956	-4,414	-7,857	-5,390	-778	-16,483
Percentage Difference	+4.6	-12.6	-5.2	-7.4	-1.1	-4.4

ASSUMING BOTTLED BEER OF TWENTY FOUR EIGHTY CASE PALLETS AND DRAUGHT BEER OF FORTY EIGHT SIX KEG PALLETS PER CARLOAD

Warehouse Location	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's	Total
Moose Jaw	3,713	2,890	13,693	3,674	6,655	30,625
Swift Current	5,248	2,025	15,984	8,085	4,816	36,158
Weyburn	4,004	3,048	17,345	5,311	6,588	36,296
Yorkton	6,021	6,526	18,920	8,863	13,573	53,903
Regina	16,782[a]	5,993	34,816	16,288[a]	16,231	90,110
Saskatoon	9,254	9,725[a]	22,900	12,067	19,581[a]	73,527
Prince Albert	8,354	3,726	11,222[a]	17,126	11,878	52,306
North Battleford	4,607	3,972	12,264	8,183	5,216	34,242
Total Cost	57,983	37,905	147,144	79,597	84,538	407,167

ASSUMING BOTTLED BEER OF FORTY EIGHT SEVENTY CASE PALLETS AND DRAUGHT BEER OF FORTY EIGHT SIX KEG PALLETS PER CARLOAD

Warehouse Location	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's	Total
Moose Jaw	3,448	2,496	12,665	3,412	5,768	27,789
Swift Current	4,717	1,782	14,986	7,000	4,238	32,723
Weyburn	3,533	2,641	16,398	4,688	6,117	33,377
Yorkton	5,200	5,832	16,581	7,673	11,634	46,920
Regina	16,782[a]	5,308	32,298	16,288[a]	14,114	84,790
Saskatoon	8,047	9,725[a]	20,634	11,287	19,581[a]	69,274
Prince Albert	7,314	3,366	11,222[a]	14,867	10,690	47,459
North Battleford	4,031	3,782	10,613	7,638	4,735	30,799
Total Cost	53,072	34,932	135,397	72,853	76,877	373,131

[a] Shipments to a warehouse from a brewery in the same city.

transportation cost of being shipped to the local warehouse. In Prince Albert, for example, many of the orders placed by retail outlets that are supplied from the Prince Albert warehouse were actually made up at the Sicks Bohemian Brewery for the portion of the order of beer from that brewery. Therefore, these direct shipments did not incur the cost of transportation to the brewery.

The actual cost of transportation for these shipments are presented in Table 22 for comparison.[7] When the estimated cost of shipping from the brewery to the warehouse located in the same city are deducted from the totals the estimated and the actual costs compare quite closely.

With the exception of shipments from Carling's Brewery in Regina the estimate is less than actual, which is as expected since in practise some shipments are made in less than carload lots and some shipments are made to the warehouse located in the same city as the brewery.

The cost of shipping from the O'Keefe brewery in Saskatoon is estimated as substantially less than actual, however since the quantity shipped from that brewery to warehouses such as those located in Moose Jaw, Swift Current and Weyburn is such that carload shipments would tend to be too infrequent for the twenty-one day turnover requirement for draught beer, the actual shipments include a larger number of less than carload shipments. The same is no doubt true for shipments made from the Carling's brewery in Regina to North Battleford, however in total the estimate for Carling's exceeds the actual cost.

[7] Actual costs as compiled by the individual breweries.

Since the analysis used an estimate of shipments out of warehouse storage for the estimate of shipments into storage, there is clearly a difference in time between when the estimate assumes the cost was incurred and when it was actually incurred. As well, the time and method of recording the actual costs does not make the two entirely comparable. Actual costs no doubt account for adjustments due to breakage and so on, which although minimal (less than half of one per cent of the total bottled beer shipped) are not accounted for in the estimate. The shipments made from breweries to warehouses located in the same city are not known but is is known that such shipments were made to fill orders for smaller quantities of that particular brewery's products. It is most likely then that the estimates are slightly greater than the actual cost that would be incurred if all shipments to outlets were made from the warehouse storage and direct shipments from the breweries did not occur.

The results of the procedure employed to estimate brewery to warehouse transportation costs relied quite heavily on the carloading assumption of a maximum of twenty-four pallets per railway car. This assumption was changed to allow forty-eight pallets of draught or twenty-four pallets of bottled beer or some combination of stacked pallets of draught beer and unstacked pallets of bottled beer. The estimated brewery to warehouse transportation costs are presented in Table 22. This does give some indication of the savings that could be expected from equipping all facilities with pallet handling equipment although for the most part, it only begs the question of further investigation of the method of loading railway cars and placing orders.

The Estimated Cost of Operating a Warehouse Facility

The cost of operating warehouse facilities for Saskatchewan beer distribution accounted for approximately thirty-five per cent of the total distribution system cost. However, as will be explained, a large portion of the warehouse operating costs are unaffected by the number, size and location of warehouse facilities. In addition, the current warehouse operating costs include costs which can be allocated to the handling of empty kegs and returned bottles which is excluded from this analysis.

The warehouse facility costs of interest in the problem of determining the number, size and location of facilities are those affected by the magnitude of the plan, that is, the costs affected by the number, size and location of facilities.

Many costs of operating a warehouse facility relate directly to the volume and vary in proportion to the volume of goods moving through the facility. These costs will be incurred regardless of the decision with respect to number, size and location provided we assume that the total volume to be supplied is not affected by the location decision. Since the SBA warehouses and the Saskatchewan breweries are the only source of supply (with the exception of small quantities of imported brands handled by the Liquor Control Board) and a one price policy is in effect, it is unlikely that the demand for brewery products by the ultimate consumer is affected by the warehouse location decision. Retail outlets are numerous and their source of supply does not affect the ultimate consumer since retail outlets generally maintain an inventory policy that prevents out-of-stock situations.

The problem is one of estimating the fixed costs of operating a

warehouse facility. If a warehouse facility is established, fixed costs that are incurred include:

1. The cost of investment in land, buildings and equipment.
2. Fixed maintenance costs.
3. Depreciation expenses.
4. Property taxes.
5. Administrative and supervisory costs.
6. Utility costs.
7. Insurance expense.

It is recognized that costs which appear to vary directly in proportion to the volume handled do so only within a certain range of volume. No doubt as the size of facility is increased from a very small size, economies of scale occur that reduce the per item variable costs. As well, beyond some optimum size diseconomies of scale would be expected that will result in an increasing per item variable cost.

Labour handling costs are typical of the type of cost that varies in proportion to the volume handled. However, manpower is not divisible into units of less than one man and some minimum number of men are necessary even when the volume handled requires less than one man. This is the case when due allowance is made for holidays, sickness and peak periods that occur when only one man would cause excessive delays. In the facility employing only two men, the addition of one more man would increase the total labour cost by fifty per cent, while if one hundred men were employed the addition of one man would increase the total labour cost by only one per cent. Thus the indivisibility of manpower is less of a problem for the larger facility.

When a facility becomes larger however, the distance in the

facility that goods must move increases. Thus at some point the economies of increasing size are offset by the increasing time required to move goods through the warehouse.

The problem of optimum size of facility is really a sub-problem of location of facilities problem. Since an examination of this problem would require extensive time studies and a review of warehouse operating costs, productivity and facility design, it is beyond the scope of this analysis to suggest the optimum facility size.

Thus with some reluctance, the assumption is made that variable costs can be identified and said to vary directly in proportion to volume for the range of facility sizes that could be required.

Some of the costs like administrative and supervisory costs are fixed over a wide range of warehouse facility sizes while others relate directly to the size or capacity of the facility established. Therefore before the fixed costs can be estimated, a method must be developed to determine the size of facility required. The present operation will first be examined to identify and describe the minimum space requirement and the current inventory stocking policy which determines the relationship between the level of sales and storage space required. Developing unit cost estimates for building construction and land the investment and cost of the investment can be determined. Following this the remaining fixed costs can be defined.

In order to determine the investment required for land, building and equipment the capacity required must be determined. According to Heskett and others:

> The determination of necessary warehouse capacity requires at least two steps. The first, a determination of the supply or market area to be served by the warehouse...

> The second is concerned with the capacity needed in a specific facility to accomodate a given supply or market territory.[8]

In this instance the market to be supplied is determined by the assignment of retail outlets to warehouse facilities. As stated previously, outlets are assigned to the closest warehouse since in this way the customer is afforded the minimum lead time the distribution system can provide from the receipt of an order to the delivery of the order. Clearly, retail outlets will order from the closest facility even if this were to result in an increase in total transportation cost for distribution from the brewery to the retail outlet. The second step requires that the relationship between capacity requirements and the level of activity of each operation be appraised.

The capacity required for each warehouse activity (i.e. receiving, stocking, shipping) is determined by the peak demand for receipt, storage and shipping of goods placed on the facility and the level of customer service that must be maintained during the peak period. Thus the storage space required for inventory must be sufficient to provide for the peak periods of activity that can occur under a given service policy.

The inventory held during the other periods is irrelevant to the decision on space requirements, particularly when the peak requirement for each activity coincides or overlaps with others. The same reasoning is no less true for truck and rail dock facilities and materials handling equipment

For the purposes of this analysis the measure of capacity will be in terms of the total space required to meet a particular level of demand.

Warehouse space can be classified according to the activity it

---

8 Ibid., p. 401.

performs as follows:

1. Office space including washrooms, lunch room, furnace and power panel room.
2. Receiving dock space both inside and outside the building enclosure.
3. Shipping dock space both inside and outside the building enclosure.
4. Order picking area and order make up area.
5. Storage area.

The office space in the Regina warehouse, one of the newest facilities, is about 1,650 square feet. An area of approximately 400 square feet is used to receive empty bottle returns, which when excluded from the office area leaves a requirement of 1,250 square feet to provide office space to operate the warehouse for the distribution of full goods.

The new warehouses in Regina and Saskatoon enclose the shipping and receiving docks within the building. Dock areas outside the building are used primarily for empty container returns and are therefore excluded from the requirement in this analysis.

It is assumed that a receiving dock of at least two rail car capacity is required at a warehouse facility. Since this capacity is sufficient at the Regina warehouse to handle the current volume of full goods in addition to some outgoing empty containers it is assumed that this capacity will be sufficient at all warehouse facilities.

A depth of twenty feet is reported by Heskett and others to be common for warehouse docks.[9] A length of approximately seventy feet accommodates two rail cars at the Regina warehouse, thus about 1,400 square feet is required for receiving dock space.

Truck dock space is also subject to change depending upon the volume moving through the warehouse. In Regina six enclosed truck docks are provided to handle outgoing and some incoming shipments. Thus, it is assumed that six truck docks are sufficient to handle the volume at all warehouse facilities. The Regina truck docks use about the same space as the rail docks, 1,400 square feet. The standard is usually a twelve foot width and twenty foot depth for each truck dock.

The space requirements outside the building include the provision for seventy eight feet of frontage and sufficient space to accommodate vehicles for loading and unloading at the side of the building. A rail car requires about twelve feet of space between the building and the property line,[10] therefore the twenty-five foot allowance at the Regina warehouse provides for two spur lines and the possibility of through-car unloading. Highway vehicles usually require an area of twice the vehicle length for rear-end loading,[11] therefore to accommodate fifty foot vehicles a space one hundred feet in depth is required. Since the truck docks are spaced evenly on the seventy foot side of the building, an area of seven thousand square feet is required.

---

[9] Ibid., p. 410.

[10] Ibid., p. 410.

[11] Ibid., p. 409.

In order to determine dock requirements and outside space necessary to accommodate vehicles for loading and unloading, it is necessary to know not only the volume handled but also the fluctuations in inbound and outbound traffic, the degree to which traffic can be scheduled and some measure of the number and length of delays that can be tolerated. Since this information is not readily available, these space requirements have been assumed to be fixed. Although this might appear to substantially reduce the validity of the results, using a range of costs per square foot and investigating the sensitivity of the solutions to changes in cost per square foot compensates for some of the imprecision of a fixed space requirement assumption.

Order picking is done on an out-and-back selection basis. Therefore one area cannot be designated as the order picking or order make up area. Rather, the storage area is used for this purpose with the final order preparation being completed on the shipping dock. Since at least one pallet of each brand and package size must be placed on the floor without other pallets stacked on top of it to facilitate order selection, the space required for these pallets can properly be called order selection space. Table 23 lists the brands and package sizes available by brewery. In addition to these provincially produced beers, there are three out-of-province brands stored in SBA warehouses, each available only in the one dozen bottle package size.

On the basis of one pallet for each brand and package size, the order selection area must be large enough to accommodate forty pallets of bottled beer.

The warehouse space required for inventory storage varies with sales but not in direct proportion to sales. Tabulating weekly sales

TABLE 23

BRANDS AND PACKAGE SIZES OF BOTTLED BEER INVENTORY[a] IN
SASKATCHEWAN BREWERS' ASSOCIATION LIMITED
DISTRIBUTION WAREHOUSES
SEPTEMBER 9, 1968

Brewery	Brand	PACKAGE SIZE Two Dzn.	One Dzn.	Half Dzn.
Carling's	Black Label Lager Beer	X	X	X
	Calgary Export Lager Beer	X	X	X
	Red Cap Ale		X	X
Labatt's	"50" Ale		X	X
	Pilsner Beer	X	X	X
	Velvet Cream Stout		X	
Molson's	Export Ale		X	X
	Canadian Lager Beer	X	X	X
	Pilsner Beer	X	X	X
	Royal Stout		X	X
O'Keefe's	Ale	X	X	X
	Old Vienna Lager Beer	X	X	X
	Double Stout		X	X
Sicks'	Bohemian Lager Beer	X	X	X
	Imperial Stout		X	X

[a] For beer produced by breweries located in Saskatchewan according to Brewers Association of Canada Sales Bulletins.

and inventory levels for each brewery's bottled beer and draught beer in each warehouse for the peak sales period June 14, 1969 to August 16, 1969, the relationship between sales and the level of inventory is described for the current operating practise. It is recognized that the distance between the supplying brewery and a warehouse facility will influence the level of inventory maintained for that brewery's products. However the order cycle is nearly the same (one day), in all instances except for shipments from breweries located in the same city as a warehouse facility. The results of tabulating bottled beer inventory are presented in Table 24, the results for draught beer in Table 25. The relationship between the level of sales and inventory for brewery products supplied from a brewery in the same city as a warehouse was evaluated separately.

From Table 24 the average inventory of bottled beer at various sales levels was calculated and expressed as a number of days sales. On the basis of this information, the assumed relationship was derived as shown in Table 26. In a similar manner, Table 27 was determined for the average inventory of draught beer at various sales levels and expressed as a number of days sales.

Reviewing the actual inventory of bottled beer maintained at sales levels above 6,000 two dozen cases per week it appears that the inventory increases at a more rapid rate than sales. This is not as would be expected from the use of inventory control theory and tends to indicate an over compensation for the large volume fluctuations that can occur in sales at these levels, perhaps due to the more limited experience at these levels. In view of this, inventory is assumed to vary proportionately to sales above 4,500 two dozen cases per week.

TABLE 24

FREQUENCY DISTRIBUTION OF SALES AND INVENTORY[a] EACH WEEK FOR EACH WAREHOUSE AND EACH BREWERY'S BOTTLED BEER[b] JUNE 14, 1969 TO AUGUST 16, 1969

(MEASURED IN TWO DOZEN CASES)

	INVENTORY OF BOTTLED BEER										
Weekly Sales	240-480	481-720	721-960	961-1200	1201-1440	1441-1680	1681-1920	1921-2160	2161-2400	2401-2640	2641-2880
0 - 500	1		1	1	2		1				
501 - 1000	2	7	3	4	5	4	2	1	2	1	
1001 - 1500		1	2	3	3	6	5	4	4		2
1501 - 2000		2	1	3	1	4	5	6	3	3	1
2001 - 2500	1	1		3	4	2	4	8	4	6	2
2501 - 3000		1	3	4	4	2	1	7	3		1
3001 - 3500		1	1	2	2	1	1	2	1		1
3501 - 4000				2	5	2	2	3		4	1
4001 - 4500			1	1		3	3	2		3	
4501 - 5000	1			1		3		3	1		2
5001 - 5500					1	2	1	1			
5501 - 6000					1	3		3			
6001 - 6500									1		
6501 - 7000			1				1	1			
7001 - 7500		1		1							1
7501 - 8000							1		1		
8001 - 8500									1	1	
8501 - 9000											
9001 - 9500											
9501 +				1						1	
Total	5	14	13	26	28	32	27	41	21	19	11

TABLE 25

FREQUENCY DISTRIBUTION OF SALES AND INVENTORY[a] EACH WEEK FOR EACH WAREHOUSE AND EACH BREWERY DRAUGHT BEER[b]
JUNE 14, 1969 TO AUGUST 14, 1969

(MEASURED IN HALF KEGS)

Weekly Sales	INVENTORY OF DRAUGHT 0-25	24-50	51-75	76-100	101-125	126-150	151-175	176-200	201-225	226-250	251-275	276-300	Total	Average
0 - 25	80	18	4										102	19.0
26 - 50	16	24	9	1		1							51	37.0
51 - 75	2	14	19	12	4		3						54	69.0
76 - 100	2	5	8	4	4		1	1					25	74.5
101 - 125		1	3	6	4	1		2					17	100.7
126 - 150			3	2	2		3	2					12	121.8
151 - 175				2	1	1	1	1		1			7	144.6
176 - 200				1									1	87.5
201 - 225			1	1			2						4	118.8
226 - 250	1		1			1					1		4	118.8
251 - 275	1						1						2	87.5
276 - 300							1						1	162.5
TOTAL	102	62	48	29	15	4	12	6		1	1		280	

[a] Excluding sales and inventory for breweries and warehouses located in the same city.

[b] Inventory level measured at the end of each week and sales measured for the following week.

Weekly Sales	INVENTORY OF BOTTLED BEER 2881-3120	3121-3360	3361-3600	3601-3840	3841-4080	4081 4320	4321-4560	4561-4800	4801+	Total	Average
0 - 500										6	1121
501 - 1000										31	1126
1001 - 1500	1									31	1730
1501 - 2000				1						30	1871
2001 - 2500	1									36	1913
2501 - 3000	1									27	1649
3001 - 3500	2	1			1					16	1094
3501 - 4000	2	2	1	1						25	2265
4001 - 4500	2									15	1975
4501 - 5000				1					1	13	2261
5001 - 5500		1								6	1920
5501 - 6000				1						8	1980
6001 - 6500							2		1	4	4020
6501 - 7000		1	1							5	2280
7001 - 7500									1	4	3400
7501 - 8000		1		1					1	5	3384
8001 - 8500										2	2400
8501 - 9000									1	1	5880
9001 - 9500							1			1	4240
9501 +		1					2		9	14	4834
Total	9	7	2	5	1		5		14	280	

[a] Excluding sales and inventory for breweries and warehouses located in the same city.

[b] Inventory level measured at the end of each week and sales measured for the following week.

TABLE 26

AVERAGE BOTTLED BEER INVENTORY IN WAREHOUSE STORAGE MEASURED IN NUMBER OF DAYS SALES

WEEKLY SALES	ACTUAL FOR EIGHT WEEK PERIOD	ASSUMED RELATIONSHIP
0 - 500	11.2	10.0[a]
501 - 1000	5.6	6.0
1001 - 1500	5.8	5.8
1501 - 2000	4.7	4.7
2001 - 2500	3.8	3.8
2501 - 3000	2.7	2.7
3001 - 3500	1.6	2.5
3501 - 4000	2.8	2.4
4001 - 4500	2.2	2.3
4501 - 5000	2.3	2.2
5001 - 5500	1.7	2.2
5501 - 6000	1.7	2.2
6001 - 6500	3.1	2.2
6501 - 7000	1.6	2.2
7001 - 7500	2.3	2.2
7501 - 8000	2.1	2.2
8001 - 8500	1.4	2.2
8501 - 9000	3.2	2.2
9001 - 9500	2.2	2.2
9501 +	2.4	2.2

[a] Minimum of 360 cases assumed.

TABLE 27

AVERAGE DRAUGHT BEER INVENTORY IN WAREHOUSE STORAGE MEASURED IN NUMBER OF DAYS SALES

WEEKLY SALES	ACTUAL FOR EIGHT WEEK PERIOD	ASSUMED RELATIONSHIP
0 - 25	7.6	7.5[a]
26 - 50	4.9	6.0
51 - 75	5.5	5.5
76 - 100	4.3	4.6
101 - 125	4.5	4.5
126 - 150	4.4	4.2
151 - 175	4.4	4.1
176 - 200	2.3	3.0
201 - 225	2.8	2.8
226 - 250	2.5	2.7
251 - 275	1.7	2.5
276 - 300	2.6	2.5

[a] Minimum of 12 half kegs assumed.

These assumptions will tend to indicate a requirement for more storage space in large volume facilities than perhaps necessary. However, as mentioned previously, varying the cost per square foot will provide some indication of the sensitivity of the solution to measures of space requirement.

The minimum inventory for any brewery's bottled beer (in warehouses located in cities different from the brewery location) was observed to be about ten pallets of eighty, two dozen cases for all brands and package sizes. This also appears to be sufficient stock to support sales up to about the same weekly level, that is eight hundred, two dozen cases.

It should be noted that the discussion of inventory to this point has included inventory that can properly be designated as inventory in the order picking areas. Since this amounts to about eight pallets for each brewery, the minimum mentioned above would require storage space for only two additional pallets per brewery.

Draught beer is stored in a refrigerated cooler where it can be stacked to a height of six pallets when required. In this instance, a minimum floor space of two pallets of six half kegs was considered to be sufficient space. This provides storage for up to twelve pallets if one pallet is not left unstacked for order selection.

The inventory policy with respect to bottled beer and draught beer for breweries located in the same city as a warehouse was determined from a review of the inventories held during the eight week period June 14, 1969 to August 16, 1969. Bottled beer inventory varied from 117 to 1714 two dozen cases and draught beer varied from none to as many as 60 half kegs for any one brewery. Using an approximation of

35 per cent of the average daily sales each week, it was found that the inventory for both bottled and draught beer could be estimated reasonably well. Particularly when it is realized that the inventory requirement for brewery products that are shipped to a warehouse from other cities is at least 2.2 times the average daily sales this approximation is not felt to require further refinement. As a minimum, one pallet of bottled beer is assumed to be required while the requirement for draught is negligible as a minimum.

In order to relate inventory requirements at each level of sales to the warehouse space that will be necessary, some measure of space utilization must be expressed.

In Regina the warehouse pallet placement is on the square (rather than angular) with pallet stacking of bottled beer permitted up to a height of three pallets or approximately fifteen feet. The pallets are of a standard size, measuring forty-eight inches in width and thirty-eight inches in depth. For placement in the warehouse an allowance is made of an extra two inches in width and one inch in depth to provide for overhang of the bottled beer. Twelve foot isles are provided to accommodate two-way traffic and the use of fork lift equipment, walkie-type pallet trucks and carts. Allowing for three isles and stacking against outside walls, ten pallets can be accommodated across the floor of a warehouse approximately seventy feet wide. With the pallets facing the isle-ways placed singly and the others stacked to a height of three pallets, a total of eighteen pallets can be accommodated across the building in an area fifty-one inches wide. This indicates a possible space utilization factor of 0.21 square feet

of floor space per two dozen case.

In the Regina warehouse, the full goods capacity for bottled beer is reported to be about 22,160 two dozen cases. A floor plan indicates that an area 75 feet long is used, and the depth is allowed to vary as the storage space requirement changes. On the basis of a capacity of 22, 160 cases the factor of 0.21 square feet per case indicates that this 75 foot long area would have to have a width of about 62 feet. The warehouse measures 70 feet wide which appears reasonable when consideration is given to the fact that empty bottles and empty kegs use much of the remaining space.

The refrigerated walk-in cooler for the storage of draught beer in the Regina warehouse contains 675 square feet of storage area. In addition an area for the movements of goods into, and out of, the cooler is at a minimum 12 feet long and 25 feet wide, the width of the cooler. The capacity of this cooler is reported to be 780 half kegs, indicating a space utilization factor of 0. 89 square feet per half keg.

In summary, using the method outlined for determining warehouse space requirements, the Regina warehouse would require the following land and building size to have a capacity of 22, 160 two dozen cases and 780 half kegs.

Building:

Office area	1,250 square feet
Receiving dock	1,400
Shipping dock	1,400
Bottled beer storage (22, 160 x 0.21)	4,654
Draught beer storage (780 x 0.89)	674
TOTAL BUILDING SIZE	9,278 square feet

Land:

Length of the storage area (4654 ft.^{2}/70 ft. width)	66.5 feet
Length of truck stalls	100.0
Width of rail spur	25.0
Shipping dock width	20.0
Receiving dock width	20.0
TOTAL LENGTH	231.5 feet
Width of the building	70.0 feet
Frontage between the building and the property line	78.0
Allowance at the rear of the building	10.0
TOTAL WIDTH	158.0 feet
Land area required (231.5 x 158.0)	35,577 square feet

It should be noted that the office space and cooler are assumed to project from the building where a 78 foot frontage has been provided.

The above estimates compare to the actual size of the Regina warehouse and land requirement as follows:

	Actual Square Feet	Estimated Square Feet
Building	10,730	9,278
Land	48,213	35,577

The actual square footage is an estimate from building plans and the area that appears to be utilized. The site contains 123,000 square feet of property, most of which is not utilized.

The differences can be largely attributed to the additional space required to handle empty container returns, particularly the outside space which includes dock areas not enclosed in the building. The enclosed space is interchangeable, in that empty bottle and keg returns can occupy the area not required for storage of full goods during the year.

The cost of equipment and building construction in 1965 was approximately $20.00 per square foot for the new facilities established at Regina and Saskatoon. Costs of construction have been increasing

rapidly over the last three to four years. Allowing an upper limit of a forty per cent increase in the cost of establishing new facilities would not appear unreasonable, however the facilities in both Regina and Saskatoon are constructed of concrete and cement blocks which are among the more expensive construction alternatives. The SBA has indicated that future construction will likely be one of the less expensive alternatives and should not exceed the cost incurred in 1965 in spite of the increased construction costs. On this basis then the costs will be investigated in the range of from \$15.00 to \$25.00 per square foot.

The value of the property at the Regina warehouse site was estimated by the SBA at \$28,500. The value then for the 123,000 square feet of land is about \$0.23 per square foot. This land is leased, but the cost of leasing the property does not reflect a value of more than \$10,000 unless consideration is given to the fact that only a portion of the total area is required for the current facilities.

The property in Prince Albert and Yorkton is also leased. If the lease is expected to return the owner approximately ten per cent of the property value each year then the value per square foot in each of these cities can be determined. These values of approximately \$0.15 and \$0.13 per square foot for property in Prince Albert and Yorkton respectively, confirm anticipated values.

Examining the values obtained for Regina, Prince Albert and Yorkton, and relating these to the population of each of the respective cities indicates a near linear relationship between the value per square foot and population. This relationship is not unexpected, although a linear

relationship may not be strictly true. Using this relationship however does provide some guidance in selecting values for the property in each of the remaining five cities under consideration.

In Saskatoon, although the current population is less than in Regina, the property values are assumed to be slightly higher. This is felt to be characteristic of a rapidly developing area, which population projections indicate.

On the basis of the above, the following approximations were established for the land values in each of the eight cities under consideration as warehouse locations.

TABLE 28

Land Values in Eight Saskatchewan Cities

Cities	Land value per square foot
Moose Jaw	$0.15
Swift Current	0.13
Weyburn	0.13
Yorkton	0.13
Regina	0.23
Saskatoon	0.25
Prince Albert	0.15
North Battleford	0.13

Now that a procedure has been outlined for determining warehouse capacity requirements in terms of building and land size and the costs per square foot of each have been established, the nature of the fixed costs listed earlier can be discussed.

The fixed cost of the investment in buildings and equipment is considered to be seven per cent per annum on the advice of the SBA. Land is not owned in some cases, but leased from another party. In

these cases it was previously assumed that the annual lease expense is about ten per cent of the property value excluding taxes and maintenance. This assumption will continue to be made for all property.

The investment for equipment in a warehouse facility is about 13.5 per cent of the cost of constructing the building, based on the experience in Regina and Saskatoon. In addition to the cost of the investment in equipment, equipment is subject to a 20 per cent depreciation allowance (based on the undepreciated value) and also an expense of 10 per cent of the original value for maintenance and repairs each year. Thus the additional annual equipment expense amounts to approximately 4 per cent of the investment in a building.

The depreciation expense on buildings is calculated as five per cent of the undepreciated value. The expenses incurred for building maintenance and repairs in the fiscal year 1967-1968 indicates that an allowance of at least 1.5 per cent of the original investment should be made.

Property taxes were estimated using the values and rates as follows:

1. The land value was considered to be the value set out earlier of between $0.13 and $0.25 per square foot.
2. The property tax on land was estimated as five per cent of the land value.
3. The property tax on buildings was estimated as two per cent of the real value of the building.

The following table shows the estimated land values at each of the current warehouse sites based on the actual square footage and the values determined earlier. Using the actual property tax paid in the

TABLE 29

ESTIMATED LAND AND WAREHOUSE FACILITY
VALUES AS AT MARCH 31, 1968

City	Land Value[a]	Property Tax On Land[b]	Estimated Building Value[c]	Property Tax On Building[d]
Moose Jaw	$ 2,588	$ 129	$143,250	$2,865
Swift Current	1,902	95	64,300	1,286
Weyburn	1,456	73	133,650	2,673
Yorkton	1,775	89	47,200	944
Regina	28,290	1,415	174,700	3,494
Saskatoon	14,392	720	287,000	5,740
Prince Albert	6,142	307	165,900	3,318
North Battleford	3,120	156	87,750	1,755

[a] Land value approximated on cost per square foot.

[b] Property tax on land estimated at 5 percent of the value.

[c] Building value estimated as 1/.02 of the actual property tax after deducting the estimated tax for land.

[d] Actual property tax after deducting the estimated tax for land.

1967-1968 fiscal year and deducting the estimated tax for land the real value of each warehouse facility was estimated.

The average expense for administrative salaries and benefits at each warehouse facility was $15,000 per annum for the 1967-1968 fiscal year. This varied from $14,582 to 16,090, a variation of -2.8 per cent and + 7.3 per cent respectively. The SBA allocates about 31 per cent of the administrative salary expense to the return of empty containers. However, since there are normally only two personnel employed in an administrative position in each warehouse, the manager and an assistant, it does not appear reasonable to expect administrative salaries to be substantially less if the empty container return system is excluded from the system for the distribution of full goods. Therefore a fixed cost of $15,000 per year is considered to be the expense incurred for administrative personnel at each facility, a cost that would not be incurred if the facility were not established.

The fuel expense in Regina and Saskatoon averaged $1,273 during the 1967-1968 fiscal year. This represents an expense of about $0.13 per square foot in a new warehouse facility. In addition, the cost of supplying water and electrical power averaged $2,393, an expense of $0.24 per square foot.

The expense for insurance in Regina and Saskatoon averaged $700 for the 1967-1968 fiscal year, which represents an expense of about $0.07 per square foot of warehouse space.

In summary, the fixed costs of operating a warehouse facility can be determined in the following manner.

The Requirement for Building and Land -- First the size of the building and the land required must be determined. A total of 4,050 square feet is required for the office area, railway car docks for two railway cars

and truck docks to accommodate six trucks. The storage space required for full goods (bottles and kegs) is calculated using space utilization factors of 0.21 square feet per two dozen case of bottled beer and 0.89 square feet per half keg of draught beer.

The actual requirement for inventory of cases and kegs can be determined from the projected sales to be shipped from the warehouse facility and the peak sales that will occur during the year projected. In the discussion of demand, Table 8 shows 11.60 per cent of the total sales occur in July. The peak level of sales can then be related to the inventory requirement as developed and presented in Tables 26 and 27, the relationship between sales and inventory required.

The building size in square feet is known after performing the above calculations. Assuming a seventy foot building width then the length of the building is readily determined. The requirement for land follows from this. The length of the land area includes the length of the building, one hundred feet for truck stalls, twenty-five feet for the railway spurs, twenty feet for the shipping dock and twenty feet for the receiving dock. The width of the land area is fixed at one hundred and fifty-eight feet; a building width of seventy feet, frontage between the building and the property line of seventy-eight feet and an allowance at the rear of the building of ten feet.

The Cost of Investment in Land, Building and Equipment -- Once the size of the building and the land required is known the investment in facilities can be determined. The building construction cost is between $15.00 and $25.00 per square foot and the investment in land depends upon the land values at the location being considered. Land values were shown in Table 28.

The investment in equipment is considered to be 13.5 per cent of the

cost of construction. The total investment in building, land and equipment costs seven per cent per annum.

Fixed Maintenance Costs -- The annual equipment maintenance expense is twenty per cent of the cost of the equipment. An annual allowance of one and one half per cent is made for maintenance and repair of the building.

Depreciation Expenses -- Annual equipment depreciation is ten per cent of the cost of the equipment and building depreciation is determined as five per cent of the building cost.

Property Taxes -- The tax on land is calculated as five per cent of the value and the tax on the building as two per cent of its real value each year.

Administrative and Supervisory Costs -- The cost for administrative and supervisory personnel is fixed at $15,000 per annum.

Utility Costs -- The annual cost for fuel is $0.3 per square foot and water and electricity $0.24 per square foot of the building.

Insurance Expense -- Insurance expense is calculated as $0.07 per square foot of the building per year.

Using the procedure outlined in this section the effect on the total cost of operating warehouse facilities can be determined as the number, size and location of facilities is changed. With fewer facilities, each facility will have to serve more retail outlets. This will be reflected in the size of facility required.

Although the method presented in this section for determining the fixed costs of establishing a warehouse facility is intended only as a means for making approximate cost estimates, it serves the intended purpose of reflecting changes in the fixed costs of operating warehouse

facilities as the number, size and location changes.

Analyzing the distribution system using a range of construction costs for warehouse facilities reveals the sensitivity of the system to warehouse operating costs. As a result of subsequent analysis no further reginement in the procedure outlined in this section was indicated.

CHAPTER IV

THE DISTRIBUTION SYSTEM MODEL

To determine the best solution to the problem of number, size and location of distribution warehouse facilities, each possible configuration can sometimes be analyzed. This requires the calculation of the cost associated with each alternative. The cost must be based on the demand the system will be required to serve in future years.

The model of the distribution system must determine the cost of serving the demand and for each selected warehouse configuration, calculate the transportation cost from the breweries to the warehouse facilities and the transportation cost from the facilities to each census subdivision. Finally, the fixed cost of establishing each facility must be calculated based on the size required for the volume moving through each warehouse.

These calculations are based on the methods outlined in the previous chapter for projecting sales and estimating brewery to warehouse transportation costs, warehouse to outlet transportation costs and the cost of establishing a warehouse facility.

In a problem of locating distribution warehouse facilities such as the one under consideration, the combinatorial nature of the problem does not present the difficulty experienced with larger problems. With m possible facilities and when at least one facility must be established there are $2^m - 1$ possibilities. Thus, for the current problem with eight possible facilities there are 255 solutions to be evaluated. In larger problems the time required to evaluate all the solutions becomes prohibitive even with the use of a digital computer.

However, a problem with 255 solutions can be evaluated efficiently.

Model Description

In Chapter III and the discussion of demand, a method was developed for projecting demand in each of the twenty-four market areas in the province and then allocating this demand to the census subdivisions contained in each market area. Table 5 of Chapter III shows the projected sales for the periods 1967-68, 1972-73, 1977-78, and 1982-83. Thus the location of facilities can be evaluated for each of these fiscal years.

The seasonal variation by month shown in Table 8 of Chapter III is used in each evaluation to reflect the distribution of sales throughout the year for the province of Saskatchewan.

Since each census subdivision is treated as a single demand point and the evaluation of all possible warehouse configurations requires the calculation of the transportation cost from each census subdivision to every possible warehouse location the transportation rate for shipments from each census subdivision to each warehouse must be determined.

Although several approaches to estimating warehouse to outlet transportation costs are possible, in this instance a census subdivision was assigned to one warehouse and the total transportation cost and weight shipped was estimated for the 1967-1968 fiscal year for the census subdivision. Given the total transportation cost and total weight shipped from a warehouse, an average transportation rate was calculated. Proceeding in this manner, successively assigning a census subdivision to one of the eight warehouse facilities, an average

transportation rate for the census subdivision was calculated for each warehouse. This procedure was followed for all census subdivisions.

The truck transportation rates prescribed February 14, 1969, the intra-city rates used previously in Chapter III and the actual 1967-68 fiscal year demand was used in calculating the average transportation rates.

The procedure developed in Chapter III for estimating the transportation cost from warehouses to retail outlets was employed using the order frequencies selected as a result of the analysis in that chapter.

In order to use these average transportation rates to estimate the transportation cost from warehouse to retail outlets for the projected demand of future years it is assumed that the ratio of gallons shipped in bottles to the gallons shipped in kegs will remain unchanged from the 1967-68 fiscal year. As well, it is assumed that the size of orders, the average distance to outlets in a census subdivision and the prescribed transportation rates will remain the same.

The preliminary procedure of the model consists of:

1. Projecting demand in each census subdivision for a selected fiscal year as outlined in Chapter III, Estimating Demand.
2. Calculating the average transportation rate for shipments from warehouse to each census subdivision as discussed previously in this chapter.
3. Selecting a per square foot construction cost for building a warehouse facility between fifteen and twenty-five dollars per square foot as developed in Chapter III, Estimating Warehouse Facility Costs.

4. Successively selecting a warehouse configuration for evaluation as outlined in the following description of the evaluation.

The evaluation of a warehouse configuration consists of:

1. Assigning each census subdivision to the distribution warehouse that is in the configuration being evaluated which can supply the census subdivision at the lowest average transportation rate from the warehouse to the census subdivision.
2. Calculating the annual shipping cost from warehouses to census subdivisions from the projected gallons demanded assuming the same ratio of gallons shipped in bottles to gallons shipped in kegs as during the 1967-68 fiscal year and using the average transportation rate developed in the preliminary procedure.
3. Accumulating the annual total number of cases and kegs shipped from each warehouse by brewery based on the demand projected in each census subdivision, the ratio of gallons shipped in bottles to gallons shipped in kegs during the 1967-68 fiscal year and the brewery market shares by market area shown in Chapter III, Table 7 for the 1967-68 fiscal year.
4. Calculating the annual brewery to warehouse shipping cost using the procedure developed in Chapter III, Estimating Brewery to Warehouse Transportation Costs. In this instance, the measure of seasonal variation is that developed in Chapter III, Estimating Demand. A carload is defined as twenty-four pallets of either eighty two-dozen cases of bottled beer per pallet or six half kegs per pallet or some

combination of pallets of bottles and kegs. The volume shipped is that accumulated above.

5. Calculating the annual fixed cost for the facilities established according to the configuration selected using the procedure developed in Chapter III, Estimating Warehouse Facility Costs. This is based on the volume of cases and kegs shipped from a facility as accumulated above and the construction cost per square foot selected in the preliminary procedure. An annual cost of capital of seven per cent is used.
6. Determining the total annual cost associated with the selected configuration for the particular fiscal year under consideration consists of accumulating the cost of transportation from breweries to warehouses, warehouses to census subdivisions and the fixed cost for establishing the distribution facilities.

The data required by the model was prepared on punched cards and copied onto magnetic computer tape for processing. The model itself was programmed in FORTRAN IV and run on the IBM 360/67 computer system.

Distribution System Model Results

The distribution system model was run a number of times with changes in the parameters each time. In this way results were obtained for the base fiscal year of 1967-1968 as well as the projected years of 1972-1973 and 1982-1983 using a cost of construction of \$15.00 per square foot and \$25.00 per square foot. At this point the results obtained were analyzed to determine whether subsequent alterations in the parameters would be necessary to evaluate the distribution system and

produce sufficient evidence to base a conclusion on.

The number of solutions that are less expensive to operate than establishing eight warehouse facilities are summarized below for the selected years and building construction cost of $15.00 per square foot and $25.00 per square foot. In addition, the number of solutions that are not more than ten per cent greater than the cost of operating all eight facilities is shown.

TABLE 30

The Number of Solutions Less Expensive

Than Establishing Eight Facilities

Year	Solutions costing less than eight facilities		Solutions costing not more than ten per cent greater than eight facilities	
	at construction cost of		at construction cost of	
	$15.00 ft.^{2}	$25.00 ft.^{2}	$15.00 ft.^{2}	$25.00 ft.^{2}
1967-68	2	7	74	87
1972-73	0	2	63	73
1982-83	0	0	50	41

It was expected that the increased cost of construction would result in more solutions less expensive than operating eight facilities, other factors being equal. What is not apparent is the fact that the number of solutions less expensive than establishing all eight facilities is reduced as the demand increases in successive years. It is also significant that a large number of solutions exist that are in close proximity to establishing all eight facilities.

The greatest number of solutions that are better than establishing all eight facilities occurs for the base fiscal year of 1967-68 and a building construction cost of $25.00 per square foot. These are as follows

in Table 31.

TABLE 31

Solutions for Establishing Distribution Warehouse Facilities Less than the Cost of Establishing Eight Facilities for 1967-1968 with a Construction Cost of $25.00 per Square Foot

Warehouse Facilities to be Established MJ	SC	WY	YK	RG	SK	PA	NB	Annual Cost Factor
X	X	X	X	X	X	X	X	$1,716,595
	X		X	X	X	X	X	1,694,037
X	X		X	X	X	X	X	1,699,790
	X		X	X	X	X		1,700,659
X	X		X	X	X	X		1,706,406
X			X	X	X	X	X	1,707,255
	X	X	X	X	X	X	X	1,712,532
X			X	X	X	X		1,713,609

It must be noted, as stated previously, that the solution costs shown are not total estimated annual operating costs. Costs which are not affected by the configuration selected are not included since they will be incurred regardless of the alternative chosen. For example, the labour cost incurred handling material in the warehouses is assumed to be in this category. Thus, although labour cost is a large and important cost to be considered in the total annual operating cost, it is excluded from the cost figure shown for any solution.

In the previous table, it is noted that only four facilities are candidates for elimination, Moose Jaw, Swift Current, Weyburn and North Battleford. It is also of interest that the eight configurations shown above are the best solutions regardless of the year, although the order of solutions in terms of cost within the group of seven solutions is different in different fiscal years.

In analyzing the solutions obtained the important point is the cost difference between establishing all eight facilities and the other solutions. The difference is important for at least two reasons: (1) the current distribution system utilizes facilities at all eight locations and (2) the least cost solution in every case is all eight facilities or a cost very near the cost for establishing all eight facilities.

In other words, a decision with respect to eliminating distribution warehouse facilities will be made with reference to the cost of operating all eight facilities. The differences are summarized in the following table.

The above results also indicate that if one warehouse is to be eliminated it is the Weyburn warehouse, for the elimination of two warehouses, Moose Jaw and Weyburn, while for three warehouses they are Weyburn, Moose Jaw and North Battleford. This is true regardless of the cost of construction in the range from $15.00 to $25.00 per square foot.

The sensitivity of the solutions to changes in the transportation rate is quite important as mentioned previously. In all cases analyzed, an increase in the transportation cost without corresponding increases in other costs would make the establishment of more facilities more attractive. In fact only a very small increase (2 to 4 per cent) would make the establishment of all facilities the least cost solution in all cases examined except fiscal year 1967-68 at a construction cost of $25.00 per square foot.

Alternatively, a decrease in the transportation costs of as much as ten per cent results in some solutions costing less than

TABLE 32

SOLUTIONS TO THE NUMBER AND LOCATION OF DISTRIBUTION WAREHOUSE FACILITIES

Year	Cost For All Facilities	Cost Difference From All Facilities With Distribution Warehouse Facilities Eliminated At						
		WY	MJ, WY	MJ	SC, WY	WY, NB	MJ,WY,NB	SC,WY,NB
Construction Cost of $15.00 ft.^{2}								
1967 - 1968	$1,615,128	$- 5,992	$- 550	$+ 7,250	$+12,511	$+10,992	$+16,441	$+29,245
1972 - 1973	1,873,451	+ 703	+11,370	+13,111	+29,618	+27,091	+37,631	+55,900
1982 - 1983	2,620,425	+20,953	+42,549	+25,323	+79,768	+77,065	+98,131	+135,480
Construction Cost of $25.00 ft.^{2}								
1967 - 1968	1,716,595	-16,805	-22,558	- 4,063	- 9,340	-10,189	-15,936	- 2,986
1972 - 1973	1,979,231	- 9,881	-10,243	+ 2,092	+ 8,053	+ 6,026	+ 5,537	+23,799
1982 - 1983	2,741,520	+10,507	+21,357	+14,743	+58,839	+55,643	+65,963	+103,806

establishing all eight facilities. For fiscal year 1967-68 at a construction cost of $15.00 per square foot one more solution becomes less expensive than all eight facilities, for fiscal year 1967-68 at a $25.00 per square foot construction cost, six more solutions become less expensive and for fiscal year 1972-73 one more solution becomes less expensive than establishing all eight facilities for construction costs of both $15.00 and $25.00 per square foot. In fiscal year 1982-83 no solutions result in a cost less than establishing all eight facilities even when the transportation cost is reduced by as much as ten per cent. As well, reducing or increasing the transportation costs by ten per cent does not change the ordering of the solutions that are less than the cost of establishing all eight facilities even when the transportation cost is reduced by as much as ten per cent. As well, reducing or increasing the transportation costs by ten per cent does not change the ordering of the solutions that are less than the cost of establishing all eight facilities.

The appendix contains in detail the results summarized in Table 32. This includes the maximum inventory for each warehouse, building and land requirements, shipping costs and the fixed costs of operating each facility for all solutions obtained that have a total cost less than or equal to the cost associated with establishing eight facilities.

Conclusion

The objective of the analysis of the Saskatchewan beer distribution system was less one of finding 'the optimum solution' to the number, size and location of distribution warehouse facilities than one of providing conclusive evidence of the direction in which the optimum

solution lies. This has certainly been accomplished. Following any of the solutions shown in Table 32 for successive periods, regardless of the building construction cost the solution becomes less and less attractive. The result is that by 1982 all solutions for fewer than eight distribution warehouse facilities will incur a greater expenditure than the solution of establishing all eight facilities.

The task of determining those configurations that merit consideration has been accomplished in that seven configurations as alternatives to establishing eight warehouse facilities have been isolated. These solutions are the best or next best alternatives irrespective of the year or building construction cost selected.

In defining the objectives of this analysis it was stated that the concern was primarily with determining which warehouse facilities could be eliminated, if any. Certainly the analysis could have been extended to consider other locations, but the current warehouse facilities are located in the largest population centers in each area and only a few other centers would be feasible in Saskatchewan where the population is predominately rural.

This approach gains support in that the only facilities which show any prospect for discontinued use are those located in the smaller population centers and in particular those in the southern portion of the province where the population has been projected as declining in size. Other population centers which could be considered as locations for warehouse facilities are for the most part located in the southern regions of the province.

The analysis can be cited as deficient in one respect at least.

Each year analyzed has been treated as a period independent of the previous and future periods. In practise this is not true since a warehouse facility required in the 1972-73 period will have to be built with at least the 1982-83 period in consideration. Unless modular expansion can be employed a facility constructed today must be large enough to accomodate peak future volumes. If the volume of goods moving through a facility is increasing then the necessity of constructing a larger facility now would tend to favor the establishment of fewer facilities. However, this is not a serious limitation in this study since the solutions have been shown to be quite insensitive to the fixed cost of operating warehouse facilities.

The assumption that economies of scale do not occur as the size of facility increases could be a limiting factor on this analysis since labour costs are such a large part of the total cost to operate a warehouse facility. However, it must be noted that this is not a very limiting factor. Cost savings in areas of variable cost will have to be quite substantial to invalidate the conclusion of this study, namely, that the trend is toward more distribution warehouse facilities and the optimum lies in the direction of eight or more such facilities.

It has been pointed out earlier that the accuracy of the entire analysis of a distribution system depends upon the accuracy and validity of the data and assumptions made about demand and where it is located. Unfortunately regional growth or decline due to the economic expansion or contraction of particular industries cannot be adequately predicted. It can be stated with some confidence though that the trend toward urbanization and the population growth of Saskatchewan can be expected to

continue. Thus, even if the demand forecast is thought to be unreasonable, the increase in sales by area in approximate relation to population growth must be agreed. Therefore, the same conclusion with respect to the establishment of distribution warehouse facilities will be reached but perhaps in a shorter or longer period of time depending upon the judgement of the reader.

Some general comments can be made about the behavior of the distribution system.

If transportation costs decrease, and that would be unlikely if the historical movement of costs is considered, solutions with fewer than eight facilities might be reasonable for a longer period of time but even then the movement is toward more facilities.

Transportation costs are by far the greatest part of the cost in any solution. Thus, an increase or decrease in transportation costs tends to affect all solutions nearly the same. As a result, even if the model produces results which may vary slightly from reality, the optimum solution is probably still very nearly optimal in the model. That is, the costs shown may not reflect true cost savings possible, except within limits, however cost savings do exist and are no doubt greatest for the solution shown that is of least cost in the model.

Table 22 of Chapter III points out an area of distribution system costs that could very well lead to some substantial savints. The cost of transportation from the breweries to distribution warehouses is estimated using three different methods of loading railway cars. Placing pallets only one high results in an annual cost of $429,154, while stacking pallets two high results in an annual cost of $373,131, a difference of $56,023 or 13.1 per cent. Although other factors are

involved in the method of railway car loading in addition to those considered in the above estimates, this certainly points out an area worthy of further investigation.

The mode of transportation appears unlikely to change, that is, by railway from breweries to warehouses and by truck from warehouses to retail outlets. However, the means used to obtain this service might be altered. The SBA could become directly involved in trucking operations or contractual arrangements could be made that would also give consideration to the empty container return system. The area of transportation is the sub-problem of the distribution system with the largest potential for savings.

Changes in brewery market share will affect costs and have some influence on the optimality of the solution to the problem of distribution warehouse facilities. It is known though, that substantial changes in market share occur only over longer periods of time and the fact that breweries are located in only three of the Saskatchewan cities tends to reduce the effect of market share changes. Change in market share is more a question of a significant change in volume distributed from the three brewery cities than for changes among all breweries.

In Chapter III it was noted that the actual inventory of bottled beer maintained at sales levels above 6,000 two dozen cases per week the inventory increases at a more rapid rate than sales. This is not as would be expected from the use of inventory control theory and tends to indicate an over compensation for the large volume fluctuations that can occur in sales at these levels, perhaps due to the more limited experience at these levels.

This would suggest a review of the inventory stocking and ordering

policy which could very well accompany an analysis of the transportation system. Inventory carrying costs are not substantial in relationship to other distribution system costs. Although the inventory stocking policy determines the amount of space required at each warehouse facility the fixed cost of operating a warehouse facility is not a critical factor in determining the number, size and location of distribution warehouse facilities. Therefore an analysis of the inventory stocking and ordering policy does not require further analysis for the purposes of this study.

Potential savings with respect to inventory stocking and ordering policy are probably to be gained as much at the breweries as they are in the distribution system. No doubt the inventory policy has a considerable effect on production scheduling and storage space requirements at each brewery.

A statement of the optimum facility size that takes into account warehouse operating costs, productivity and facility design has not been attempted. Although this is an area that could produce some reductions in expense the reduction would most likely be in terms of reduced labour costs rather than any substantial reduction in space requirements or other warehouse operating costs.

Undoubtably an analysis of the warehouse would include the determination of dock requirements and outside space necessary to accommodate vehicles for loading and unloading which is a problem of some substance in itself.

It was previously stated that specific optimums are precluded due to the dynamics of a distribution system. This becomes clear in the

system analyzed. Although fewer facilities appears optimal in the early years, the same number of facilities is less than optimal as demand is projected into the future.

If the system examined in this instance was not yet established, the results obtained would serve well in developing a plan for the establishment of warehouse facilities. In the early years a few facilities could be established and at a size adequate to meet the expected volume in the short run. In time, additional facilities could be established that would offset any size limitation in established facilities and at the same time re-establish a near optimal distribution system. The results obtained for size, number and location of distribution warehouse facility at various levels of demand in different years provides the guide to planning the development of a distribution system.

In the present situation, where the facilities already exist it is unlikely that any saving would be incurred by closing and reopening facilities due to the administrative expense, cost of disruption and associated reorganization required. The decision to close and later reopen warehouse facilities depends upon the length of time that the system will operate at a sub-optimal level if the facility remains in use and the cost incurred during that period of time in relation to the cost of disruption and the associated reorganization in discontinuing facilities. As well, potential cost savings from economies of scale occurring in the actual operation of few but larger warehouse facilities must be considered.

The priorities listed earlier for either reconstruction or discontinued use of distribution warehouse facilities was North Battleford, Yorkton, Moose Jaw, Weyburn and Swift Current. From the results obtained

the discontinued use of the North Battleford or Yorkton facilities would result in a greater annual cost than their reconstruction. Moose Jaw and Weyburn could be discontinued in the short run. However, the discontinued use of the Swift Current facility by itself would result in a greater annual expense.

The plan of action that suggests itself from the priorities given above for reconstruction or discontinued use of distribution warehouse facilities and reviewing the results of this analysis is the reconstruction of the facilities at North Battleford, Yorkton, Moose Jaw, Weyburn and Swift Current. Reconstruction on this basis, planned over a period of years will permit the continued evaluation of the distribution system. If the projected demand falls short of the estimate or other factors change significantly the most likely facilities to be discontinued will be among the last scheduled for reconstruction. At the same time, the relative urgency for reconstruction can be followed according to priority.

BIBLIOGRAPHY

Brewers' Association of Canada, Brewing In Canada, Ronalds-Federated Limited, Montreal, 1965.

Churchman, C. West, Russell L. Ackoff, E. Leonard Arnoff, Introduction To Operations Research, New York, 1957, John Wiley & Sons, Inc.

Cooper, Leon, Location-Allocation Problems, Operations Research, Volume 11, Number 3, (May-June 1963).

Freud, John E., Frank J. Williams, Modern Business Statistics, Prentice-Hall Inc., Englewood Cliffs, N.J., 1958.

Heskett, J. L., Robert M. Ivie, Nicholas A. Glaskowsky Jr., Business Logistics, Management of Physical Supply and Distribution, Ronald Press Company, New York, 1964.

McElhinery, Paul T., Charles L. Hilton, Introduction to Logistics and Traffic Management, Wm C. Brown Company, Publishers, Dubuque Iowa, 1968.

Pitfield, MacKay Ross & Company, Annual Review of Molson Industries, n.p., January 1969.

Southern News Service Ltd., The Edmonton Journal, Edmonton, Alberta, February 7, 1969.

Vaizey, John, The Brewing Industry 1886 - 1951, An Economic Study, Sir Isaac Pitman & Sons Ltd., London, 1960.

Warrack, Allan A., Cost Analysis in Feed Industry Location, Feedstuffs, Volume 40, Number 39, (September 1968).

Webster's Seventh New Collegiate Dictionary, Based on Webster's Third New International Dictionary, Thomas Allen & Son Limited, Toronto, Ontario, 1967.

APPENDIX

SOLUTION: MJ, YK, RG, SK, PA (SC, WY, NB ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	MJ	YK	RG	SK	PA
Maximum Inventory Of Cases	10,265	8,835	13,541	12,502	8,243
Maximum Inventory Of Kegs	595	591	396	615	412
Building Sq. Ft.	6,735	6,431	7,246	7,223	6,147
Land Sq. Ft.	30,462	29,784	32,014	31,522	29,503
Land Cost	4,569	3,872	7,363	7,880	4,425
Building @$25.00 Ft.					
Building Cost	168,373	160,778	181,143	180,570	153,683
Equip. Cost	22,730	21,705	24,454	24,377	20,747
Whse. Op. Cost	53,157	51,362	56,418	56,368	49,866
Shipping Cost Warehouse To Outlet	173,387	126,161	262,284	313,563	149,574

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	60,051	38,723	155,424	79,704	87,569

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,446,439
Warehouse Operating[a] Cost	267,171
Total	1,713,609

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, SC, WY, YK, RG, SK, PA, NB
FOR THE FISCAL YEAR: 1972-73

	MJ	SC	WY	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	8,744	8,574	8,046	9,196	12,804	12,048	7,961	8,158
Maximum Inventory Of Kegs	498	483	330	650	362	555	414	473
Building Sq. Ft.	6,329	6,280	6,034	6,560	7,061	7,074	6,090	6,184
Land Sq. Ft.	29,741	29,660	29,410	29,955	31,665	31,307	29,370	29,463
Land Cost	4,461	3,856	3,823	3,894	7,283	7,827	4,405	3,830
Building @$15.00 Ft.								
Building Cost	94,940	94,207	90,503	98,398	105,918	106,115	91,350	92,760
Equip. Cost	12,817	12,718	12,218	13,284	14,299	14,325	12,332	12,523
Whse. Op. Cost	37,912	37,650	36,777	38,637	40,907	41,035	37,063	37,307
Building @$25.00 Ft.								
Building Cost	158,233	157,012	150,839	163,998	176,530	176,858	152,251	154,604
Equip. Cost	21,361	21,197	20,363	22,139	23,832	23,876	20,554	20,872
Whse. Op. Cost	50,884	50,521	49,143	52,081	55,379	55,534	49,544	49,982
Shipping Cost Warehouse To Outlet	58,942	93,756	81,202	145,639	184,108	223,105	142,718	85,872

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	78,328	52,412	200,119	104,709	115,254

Cost Summary	At $15.00 Construction Cost	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,566,141	1,566,164
Warehouse Operating[a] Cost	307,287	413,068
Total	1,873,451	1,979,231

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, SC, WY, YK, RG, SK, PA, NB
FOR THE FISCAL YEAR: 1982-83

	MJ	SC	WY	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	8,812	10,204	10,049	11,819	21,241	22,662	11,592	9,962
Maximum Inventory Of Kegs	505	555	380	841	515	902	570	624
Building Sq. Ft.	6,350	6,687	6,499	7,281	8,969	9,612	6,991	6,697
Land Sq. Ft.	29,773	30,433	30,359	31,198	35,664	36,338	31,091	30,318
Land Cost	4,466	3,956	3,947	4,056	8,203	9,084	4,664	3,941
Building @$15.00 Ft.								
Building Cost	95,250	100,298	97,479	109,209	134,532	144,179	104,872	100,456
Equip. Cost	12,859	13,540	13,160	14,743	18,162	19,464	14,158	13,562
Whse. Op. Cost	37,985	39,091	38,430	41,194	47,749	50,141	40,269	39,126
Building @$25.00 Ft.								
Building Cost	158,750	167,163	162,465	182,015	224,220	240,299	174,787	167,426
Equip. Cost	21,431	22,567	21,933	24,572	30,270	32,440	23,596	22,603
Whse. Op. Cost	51,000	52,795	51,749	56,116	66,131	69,841	54,598	52,852
Shipping Cost Warehouse To Outlet	68,453	127,362	117,794	193,127	270,549	331,235	205,599	111,591

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	123,155	82,119	309,963	164,015	181,480

Cost Summary	At $15.00 Construction Cost	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	2,286,439	2,286,439
Warehouse Operating[a] Cost	333,987	455,082
Total	2,620,425	2,741,520

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, SC, YK, RG, SK, PA, NB (WY ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	MJ	SC	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	8,327	7,672	8,835	13,407	9,313	7,413	7,249
Maximum Inventory Of Kegs	446	475	591	391	436	363	463
Building Sq. Ft.	6,196	6,084	6,431	7,213	6,394	5,930	5,984
Land Sq. Ft.	29,543	29,233	29,784	31,951	30,010	29,110	29,032
Land Cost	4,431	3,800	3,872	7,349	7,503	4,366	3,774
Building @$15.00 Ft.							
Building Cost	92,938	91,254	96,467	108,198	95,910	88,947	89,767
Equip. Cost	12,547	12,319	13,023	14,607	12,948	12,008	12,119
Whse. Op. Cost	37,439	36,949	38,181	41,451	38,595	36,494	36,597
Building @$25.00 Ft.							
Building Cost	154,897	152,091	160,778	180,330	159,849	148,245	149,612
Equip. Cost	20,911	20,532	21,705	24,345	21,580	20,013	20,198
Whse. Op. Cost	50,137	49,418	41,362	56,235	51,700	48,647	48,862
Shipping Cost Warehouse To Outlet	53,715	81,575	126,161	257,934	186,128	120,247	76,747

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	62,776	42,019	159,423	84,498	92,207

Cost Summary	At $15.00 Construction Cost	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,343,430	1,343,430
Warehouse Operating[a] Cost	265,707	356,361
Total	1,609,136	1,699,790

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: SC, WY, YK, RG, SK, PA, NB (MJ ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	SC	WY	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	7,541	8,017	8,736	13,268	9,396	7,413	7,249
Maximum Inventory Of Kegs	482	287	589	406	442	363	463
Building Sq. Ft.	6,063	5,989	6,408	7,198	6,417	5,930	5,984
Land Sq. Ft.	29,170	29,396	29,737	31,885	30,050	29,110	29,032
Land Cost	3,792	3,821	3,866	7,334	7,512	4,366	3,774
Building @$25.00 Ft.							
Building Cost	151,565	149,716	160,212	179,947	160,413	148,245	149,612
Equip. Cost	20,461	20,212	21,629	24,293	21,656	20,013	20,198
Whse. Op. Cost	49,300	48,893	51,235	56,147	51,827	48,647	48,862
Shipping Cost Warehouse To Outlet	85,064	71,2561	125,953	237,406	189,747	120,247	76,747

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	63,867	42,791	163,234	85,798	95,514

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,357,622
Warehouse Operating[a] Cost	354,911
Total	1,712,532

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and exludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, SC, YK, RG, SK, PA, NB (WY ELIMINATED)
FOR THE FISCAL YEAR: 1972-73

	MJ	SC	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	8,744	8,574	9,241	16,698	12,048	7,961	8,158
Maximum Inventory Of Kegs	498	483	659	400	555	414	473
Building Sq. Ft.	6,329	6,280	6,577	7,913	7,074	6,090	6,184
Land Sq. Ft.	29,741	29,660	29,976	33,511	31,307	29,370	29,463
Land Cost	4,461	3,856	3,897	7,708	7,827	4,405	3,830
Building @$25.00 Ft.							
Building Cost	158,233	157,012	164,434	197,821	176,858	152,251	154,604
Equip. Cost	21,361	21,197	22,199	26,706	23,876	20,554	20,872
Whse. Op. Cost	50,884	50,521	52,179	60,181	55,534	49,544	49,982
Shipping Cost Warehouse To Outlet	58,942	93,756	145,955	309,643	223,105	142,718	85,872

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	77,504	51,577	194,496	103,653	113,305

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,600,525
Warehouse Operating[a] Cost	368,825
Total	1,969,350

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: SC, YK, RG, SK, PA, NB (MJ AND WY ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	SC	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	7,541	8,835	16,601	9,396	7,413	7,249
Maximum Inventory Of Kegs	482	591	459	442	363	463
Building Sq. Ft.	6,063	6,431	7,945	6,417	5,930	5,984
Land Sq. Ft.	29,170	29,784	33,465	30,050	29,110	29,032
Land Cost	3,792	3,872	7,697	7,512	4,366	3,774
Building @$15.00 Ft.						
Building Cost	90,939	96,467	119,177	96,248	88,947	89,767
Equip. Cost	12,277	13,023	16,089	12,993	12,008	12,119
Whse. Op. Cost	36,874	38,181	44,076	38,676	36,494	36,597
Building @$25.00 Ft.						
Building Cost	151,565	160,778	198,628	160,413	148,245	149,612
Equip. Cost	20,461	21,705	26,815	21,656	20,018	20,198
Whse. Op. Cost	49,300	51,362	60,359	51,827	48,647	48,862
Shipping Cost Warehouse To Outlet	85,064	126,161	345,568	189,747	120,247	76,747

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	63,157	41,814	158,404	84,888	91,885

Cost Summary	At $15.00 Construction Cost	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,383,680	1,383,680
Warehouse Operating[a] Cost	230,898	310,357
Total	1,614,578	1,694,037

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, SC, YK, RG, SK, PA (WY AND NB ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	MJ	SC	YK	RG	SK	PA
Maximum Inventory Of Cases	8,327	7,672	8,835	13,407	12,371	7,876
Maximum Inventory Of Kegs	446	475	591	391	600	409
Building Sq. Ft.	6,196	6,084	6,431	7,213	7,182	6,067
Land Sq. Ft.	29,543	29,233	29,784	31,951	31,460	29,329
Land Cost	4,431	3,800	3,872	7,349	7,865	4,399
Building @$25.00 Ft.						
Building Cost	154,897	152,091	160,778	180,330	179,556	151,687
Equip. Cost	20,911	20,532	21,705	24,345	24,240	20,478
Whse. Op. Cost	50,137	49,418	51,362	56,235	56,140	49,418
Shipping Cost Warehouse To Outlet	53,715	81,575	126,161	257,934	302,264	140,656

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	61,577	40,085	157,700	82,743	89,287

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,393,697
Warehouse Operating[a] Cost	312,709
Total	1,706,406

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, YK, RG, SK, PA, NB (SC AND WY ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	MJ	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	10,265	8,835	13,541	9,467	7,784	7,249
Maximum Inventory Of Kegs	595	591	396	451	366	463
Building Sq. Ft.	6,735	6,431	7,246	6,440	6,011	5,984
Land Sq. Ft.	30,462	29,784	32,014	30,083	29,286	29,032
Land Cost	4,569	3,872	7,363	7,521	4,393	3,774
Building @$25.00 Ft.						
Building Cost	168,373	160,778	181,143	160,993	150,264	149,612
Equip. Cost	22,730	21,705	24,454	21,734	20,286	20,198
Whse. Op. Cost	53,157	51,362	56,418	51,957	49,100	48,862
Shipping Cost Warehouse To Outlet	173,387	126,161	262,284	197,427	129,164	76,747

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	61,248	40,907	157,126	81,459	90,490

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,396,399
Warehouse Operating[a] Cost	310,856
Total	1,707,255

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: SC, YK, RG, SK, PA, NB (MJ AND WY ELIMINATED)
FOR THE FISCAL YEAR: 1972-73

	SC	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	8,808	9,241	20,293	12,146	7,961	8,158
Maximum Inventory Of Kegs	476	659	539	562	414	473
Building Sq. Ft.	6,324	6,577	8,791	7,101	6,090	6,184
Land Sq. Ft.	29,771	29,976	35,215	31,353	29,370	29,463
Land Cost	3,870	3,897	8,099	7,838	4,405	3,830
Building @$25.00 Ft.						
Building Cost	158,091	164,434	219,776	177,523	152,251	154,604
Equip. Cost	21,342	22,199	29,670	23,966	20,554	20,872
Whse. Op. Cost	50,764	52,179	65,126	55,684	49,544	49,982
Shipping Cost Warehouse To Outlet	97,529	145,955	406,680	227,469	142,718	85,872

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	77,930	51,217	193,484	104,089	112,768

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,645,710
Warehouse Operating[a] Cost	323,278
Total	1,968,988

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: SC, YK, RG, SK, PA (MJ, WY, NB ELIMINATED)
FOR THE FISCAL YEAR: 1967-68

	SC	YK	RG	SK	PA
Maximum Inventory Of Cases	7,541	8,835	16,601	12,453	7,876
Maximum Inventory Of Kegs	482	591	459	606	409
Building Sq. Ft.	6,063	6,431	7,945	7,204	6,067
Land Sq. Ft.	29,170	29,784	33,465	31,499	29,329
Land Cost	3,792	3,872	7,697	7,875	4,399
Building @$25.00 Ft.					
Building Cost	151,565	160,778	198,628	180,111	151,687
Equip. Cost	20,461	21,705	26,815	24,315	20,478
Whse. Op. Cost	49,300	51,362	60,359	56,265	49,418
Shipping Cost Warehouse To Outlet	85,064	126,161	345,568	305,883	140,656

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	61,959	39,880	156,689	83,132	88,964

Cost Summary	At $25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,433,956
Warehouse Operating[a] Cost	266,704
Total	1,700,659

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.

SOLUTION: MJ, SC, WY, YK, RG, SK, PA, NB
FOR THE FISCAL YEAR: 1967-68

	MJ	SC	WY	YK	RG	SK	PA	NB
Maximum Inventory Of Cases	8,327	7,672	7,799	8,736	10,631	9,313	7,413	7,249
Maximum Inventory Of Kegs	446	475	286	589	323	436	363	463
Building Sq. Ft.	6,196	6,084	5,942	6,408	6,570	6,394	5,930	5,984
Land Sq. Ft.	29,543	29,233	29,293	29,737	30,635	30,010	29,110	29,032
Land Cost	4,431	3,800	3,808	3,866	7,046	7,503	4,366	3,774
Building @$15.00 Ft.								
Building Cost	92,938	91,254	89,134	96,127	98,545	95,910	88,947	89,767
Equip. Cost	12,547	12,319	12,033	12,977	13,304	12,948	12,008	12,119
Whse. Op. Cost	37,439	36,949	36,454	38,101	39,144	38,595	36,494	36,597
Building @$25.00 Ft.								
Building Cost	154,897	152,091	148,556	160,212	164,242	159,849	148,245	149,612
Equip. Cost	20,911	20,532	20,055	21,629	22,173	21,580	20,013	20,198
Whse. Op. Cost	50,137	49,418	48,632	51,235	52,609	51,700	48,647	48,862
Shipping Cost Warehouse To Outlet	53,715	81,575	68,789	125,953	152,656	186,128	120,247	76,747

	Carling's	O'Keefe's	Sicks'	Molson's	Labatt's
Shipping Cost Brewery To Warehouse	63,469	42,719	164,124	85,390	93,844

Cost Summary	At \$15.00 Construction Cost	At \$25.00 Construction Cost
Shipping Breweries To Warehouses and Warehouses To Outlets	1,315,355	1,315,355
Warehouse Operating[a] Cost	299,773	401,240
Total	1,615,128	1,716,595

[a] Note that the operating cost includes only those costs affected by the number and location of warehouses and excludes costs that would be incurred regardless of the warehouse configuration.